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Contents

	PAGE
Industrial Casualties	171
Correspondence	172
Iron and Steel Exports	172
Copper Supply Position	172
Random Shots	172
Hot-Tinning of Iron Castings	173
Determination of Carbon in Low-Carbon Iron and Iron Alloys	174
Notes from the Branches	174
Surface Treatment of Magnesium Alloys	175
Care of Chipping Hammers	178
New Labour Force for Industry	178
Nickel Industry in 1940	178
South African Industry at War	179
Cast-Iron Electrodes for Welding Grey Cast Iron	180
Presentation of the E. J. Fox Medal	181
British Standards Specifications	181
Some Jobbing Foundry Experiences—XX	181
The Week's News in Brief	182
Trade Talk	182
Personal	182
Obituary	182
New Companies	182
Reports and Dividends	182
Raw Material Markets	184

Industrial Casualties

There is a universal recognition of the fundamental importance of keeping the armed forces of the country as fit as possible. It is equally well appreciated that the striking power of the Navy, Army and Air Force depends upon the efficiency of the munition factories. Unfortunately, it has still to be learnt by many that industrial efficiency depends upon the health of the workers. This, then, is one of the most urgent questions of the moment, and the appearance of an authoritative book* covering the subject very completely will be generally welcomed. Having studied the publications issued from Government sources, and the several institutions concerned with various aspects of industrial welfare ever since the last war, we cannot say that Dr. Vernon's new book throws much additional light on the subject. What the author has done, however, is the careful sifting of all material published during the last two decades and the presentation of data helpful in the direction of the solution of wartime problems. For instance, good evidence is produced to indicate that the employment of women on night shift is rarely necessary and that practically an equal production can be obtained by a slightly modified two-shift system. Yet, as was pointed out in this column only last week, the Deputy Chief Inspector of Factories says that under existing conditions the two daytime shifts are not popular amongst women workers.

Being in no way qualified to judge which of these two divergent views is the correct one, we are sure that the citation of this disagreement on a fundamental principle will serve to illustrate the difficulties which will always exist in labour management. Moreover, it stresses the usefulness of Dr. Vernon's book as a pointer but not a guide for future action. With this view, we feel reasonably sure, the author will agree, for delving into no matter what section of industrial welfare, exceptions invariably loom large. The worry is that any writer on this subject, no matter how wide his experience, has a series of mental pictures as the background to his statistical data and from them draws his conclusions. If, whilst writing, his mental picture suddenly changed from an East End of London factory to one, say, in the heart of the country, a certain amount of hesitancy to be dogmatic would be apparent. There are obviously a number of well-established precepts, excellently set out in this book, which merely need interpretation by the management in the light of local conditions.

In general, the author has kept in mind the larger type of constantly-expanding munition works, wherein, owing to the influx of workers inexperienced in factory life, labour problems are more complex. He has covered the subject in eight sections. After stating the problem at issue in his first chapter, in which some illuminating statistics are given (for example, that the production of motor cycles would be sixty times greater this spring than last), the author next deals with the hours of work. Here he draws largely upon the experience he gained during the last war as an investigator for the health of munition workers. Chapter IV, covering "shift systems," would be perhaps better placed before Chapter III, which covers the question of rest pauses, a problem capable of many solutions by a competent works manager. Sickness and absenteeism, and accidents and injuries, are often consequent upon the systems of employment. In the thirty-five pages devoted to their discussion, no aspect is left untouched, but we would recommend the study of a selection of the forty-seven biographical references by those whose work includes the welfare of the employees. A chapter is devoted to the heating, lighting and ventilation of factories, a subject of increased importance since the advent of black-out conditions. The book finishes with a chapter on welfare and labour management. In it, the author reviews all the outstanding aspects of this controversial subject.

In conclusion, we deem this book to have disclosed nothing new, but it has marshalled the very considerable literature on the subject into a very orderly and readable form. By so doing, the author has performed a useful piece of work at a particularly appropriate moment, and on these grounds we commend it to the study of our readers.

D

* The Health and Efficiency of Munition Workers," by H. M. Vernon, M.A., M.D., published by Sir Humphrey Miller from the Oxford University Press, Amen House, Warwick Street, London, E.C.4. Price 8s. 6d. net.

Correspondence

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

Acid-Resisting Cast Iron

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to the article appearing in your issue dated February 13, regarding acid cast iron, one paragraph relates to caustic pots, and we would like to mention that we have on order at the present time a number of these pots, which are 9 ft. 9½ in. inside diameter by 9 ft. 6 in. deep, the pots weighing in the vicinity of 16 tons 10 cwts. each.

We have, during the past six months, made several of these pots. Pots of 7 ft. 9 in. to 8 ft. dia. by about 7 ft. 6 in. deep are being, and have been, made in this foundry every week for some time.—Yours, etc.,

R. CREDLAND
(Director and General Manager, Widnes Foundry & Engineering Company, Limited).

Widnes, Lancs.
March 4, 1941.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—With reference to the letter appearing in your issue dated February 27, regarding acid-resisting cast-iron pots, we think that the author of the Paper referred to was indicating that the largest size of pots for concentrated sulphuric acid, made to-day in this country, did not exceed 7 ft. 9 in. dia.

We, as one of the oldest makers in this country of caustic pots, make pots up to 10 ft. 7 in. dia. outside by 9 ft. 8 in. deep, weighing 16 tons. We also make the acid-resisting stills referred to, but not above the size stated—in fact, we have never been asked to make them larger.—Yours, etc.,

G. VARLEY
(for John Varley, Limited).

St. Helens, Lancs.
March 4, 1941.

Iron and Steel Exports

LICENCE APPLICATIONS

The Board of Trade announces that applications for licences to export the following goods should be addressed to the Iron and Steel Control, Ashorne Hill, nr. Leamington Spa, the envelope being marked "Export Licence Application." The Board of Trade will remain responsible for the granting or refusal of the licence. The following is the list of items:—

Ferro alloys, whether briquetted or not; iron and steel (including alloy steel) and manufactures thereof, the following:—Angles, shapes and sections, whether fabricated or not, including hollow mining drill steel but not including machinery parts; bars and rods, including hollow mining drill steel; blooms, billets and slabs; colliery arches and pit props; girders, beams, joists and pillars, whether fabricated or not; hoop and strip; ingots; pig-iron; plates and sheets of all kinds. Railway and tramway material, the following:—Buffers; springs, laminated or coiled; wheels, tyres and axles, whether assembled or not; fishplates and soleplates. Wire (including barbed wire), uninsulated, whether stranded or not, including cables and ropes. Wire nails and wire staples, but not including machine staples and insulating staples. Wire netting, wire fencing and wire mesh. Iron ores. Scrap and old metal (iron and steel).

(Continued from next column.)

to 119,736 tons, while stocks of refined copper came down to a round 116,000 short tons, this being a reduction of 26,400 tons. These figures are eloquent of the trend of events across the Atlantic and demonstrate the need for importing additional supplies from overseas in order to balance supply and demand. It is understood that these special supplies will be handled by the Metals Reserve Company, and the metal will be held in reserve until it is really wanted.

Copper Supply Position

BY "ONLOOKER."

If, as some people suggest, 1942 will show a higher total copper consumption than in the present year, the figure will be a very large one, for there cannot be any doubt that in the period up to December next usage will be on an unprecedented scale. It may well be said that nothing less than this need be expected when munition manufacture on such a gigantic scale is in progress, but one has to remember that the ordinary commercial uses of copper have been severely curtailed and, in fact, as far as this country is concerned, almost eliminated. If these were to be added to the wartime demand, the aggregate would indeed be a staggering figure.

So far, in the course of this war, the periods of heavy fighting by land have been of short duration, and it therefore follows that, with only a small expenditure of ammunition, the wastage has not been great. In consequence, there must be large reserves of shells, etc., on hand and the copper thus contained doubtless totals many thousands of tons. This has no particular bearing upon the statistical situation of this metal, and its import will only be realised when peace comes and the belligerents are left to digest the aftermath of war in the shape of excess components for which no opening can be found except as scrap.

From Glut to Famine

Looking back, it is hard to realise that not much more than six months ago U.S. copper producers seemed to be facing the prospect of a severe slump in prices through the collapse of France, who had been drawing heavily upon America for her supplies. The South American properties were the ones most vitally affected, and it seemed inevitable that severe curtailment of output would be necessary. Production actually was cut to an extent, and it is probable that a portion, at any rate, of the outstanding balances on French contracts with the States were taken over by the British Ministry of Supply. Arrangements were made to employ foreign copper lying in U.S. bonded warehouses for fabrication and re-export, and in one way and another much was done to bring relief to a difficult situation.

The change came in the autumn, when America began to wake up to her peril in the light of the German menace, but it was only after the Presidential election that the volume of the munitions programme in the United States became apparent. Now that the Lease and Lend Bill seems about to be put on the Statutes Book, the drive to create offensive weapons, both for national uses and for Great Britain, is gathering greater momentum, and it is increasingly evident that the call for copper will attain huge proportions. From a threatened glut America has been obliged to envisage the possibility of something approaching a famine, and steps are being taken accordingly.

These steps take the form of heavy purchases from South America, and it must be presumed that Chile will find most of the copper required. Some 200,000 short tons have been bought, and it seems quite likely that more will be required before the present year is out. Britain is to have the advantage of additional supplies from the Katanga property in the Belgian Congo, and in this connection it has been announced that some 125,000 tons will be forthcoming. This contribution, added to the quantities made available by Canada and Rhodesia, will make an imposing total for use during 1941, but in view of the magnitude of our war effort, it is likely that all this will be required

In the U.S.A. the consumption of copper is increasing, and the January statistics show that deliveries were up by about 7,000 short tons

(Continued in previous column.)

Random Shots

During a discussion on the problems of the singing propeller by members of the Institution of Mechanical Engineers, Mr. L. C. Burrill played a gramophone record of the noise of a singing propeller as heard in different parts of a ship. . . . Lovers of sea-shanties are not advised, however, to include this record in their collection, as the "aural sensation" of a singing propeller has been described in the lecture which preceded the discussion as a "hum, squeak, grind, squawk, rasp, twang and saw."

* * *

Not all propellers sing, for the authors of the lecture—Prof. W. Kerr, Dr. J. F. Shannon and Dr. R. N. Arnold—"admitted the significance of internal hysteresis damping . . . such damping being naturally high with cast-iron propellers, in which singing was almost unknown. . . ." And, indeed, who could blame a propeller for not feeling like singing during an acute attack of *hysteresis dampitis*?

* * *

That "war paint" is only appreciated in peace time is illustrated by a conversation "Marksman" overheard in a London bus. A young lady was chatting with her friend in a voice which focused everyone's attention on the couple.

"And they hadn't any rouge in the shop at all," she wailed in loud complaint, "no eyebrow pencil, and only one shade of lipstick, if you please!"

A tired-looking business man was sitting just behind, apparently lost in thought, but suddenly woke up and retorted in a stentorian voice: "And a good job, too!" Whereupon the rest of the passengers, all men, sang out, "Hear! hear!"

* * *

A gardening note states that "Last year's shortage of onions can hardly recur, for all who can get seeds will certainly sow a patch when the ground is in a friable condition." And look forward, it might be added, to the time when the onions will also be in a friable condition.

* * *

"Hi, mister cupola tenter," called out the young apprentice, "there's an incendiary bomb on that there heap of coke."

"If it's on that last delivery, it don't matter," drawled the furnaceman, unconcernedly, "for it won't burn anyway."

* * *

The spirit that is going to win this war is shown in the adaptability and cheerfulness of thousands of people in this country who just "carry on" under difficult conditions. Only last week "Marksman" heard from a friend whose office had suffered badly in a recent raid. This is how his letter runs:—". . . Quel lark! Someone had taken my ladder, so there was I sitting on the roof taking down a client's will on a bit of sisalkraft, which I threw down to him to be signed."

* * *

Humour, too, is another of the qualities which are beating Hitler's little game of terror. A house-decorator's shop had been partly destroyed by a bomb, and the owner had displayed a notice on what was left of the door, bearing the simple words: "Professional Jealousy!" Inside the shop half an advertisement for a certain brand of paint still clung to the wall; it read: "The perfect finish." Some wit had added underneath the words, "to the house-painter who sits in Berlin."

"MARKSMAN."

THE COLEMAN FOUNDRY EQUIPMENT COMPANY, LIMITED, recently had one of its shops damaged by fire. General business has not been unduly affected.

Hot-Tinning of Iron Castings

By C. E. HOMER, B.Sc., Ph.D.

This information is taken from "Hot-Tinning," a publication recently issued by the Tin Research Institute from their laboratories at Greenford, Middlesex.

Present Position of Hot-Tinning

The art of coating metals with tin by dipping them into the molten metal is of considerable antiquity, and it is still the most widely used method of tinning. Until recently there was no satisfactory alternative tinning process, but in the last few years there have been considerable advances in the art of electro-depositing tin. Electro-tinning is now an entirely satisfactory process for industrial use, and gives effective protection to a variety of basis metals.

The principal features of the hot-tinning process are:—

(1) The process may readily be applied to mild steel, carbon steels, copper and many copper alloys. It also gives satisfactory results on cast iron provided that the basis metal is given special preparation. Some alloy steels and copper alloys are not suitable for hot-tinning.

(2) The average thickness of coatings applied to fabricated articles by hot-tinning is 0.0005 to 0.001 in. This is a limitation of the process, since for some purposes a much thicker coating would be an advantage, as it would give longer service. Electro-tinning, on the other hand, gives coatings of any desired thickness.

(3) Bright lustrous coatings may be obtained without polishing, and they do not tarnish readily in the atmosphere. Electro-deposited tin coatings are matt when they emerge from the plating bath and give only a satin finish when polished.

(4) The plant required is simple; for articles on which a finish of the best appearance is not essential, one tinning pot and an unheated pickling tank are all that is needed.

(5) Laboratory control of the process is not necessary.

(6) The tinning operation is rapid, since the time of dipping is generally only a few seconds. On the other hand, articles can usually be dipped only one at a time.

(7) Tin-lead alloy coatings may be applied as easily as pure tin, thus reducing the cost for certain types of work.

(8) The hot-dipping process can be used to effect tinning and soldering simultaneously, as in the manufacture of motor-car radiators.

(9) Fabricated parts containing soft-soldered joints cannot be hot-tinned without melting the solder in the joints. Brazed and welded joints are, however, unaffected by the heat of the tinning operation.

Usually the hot-tinning process is operated by tinners who rely on their experience and personal skill rather than on scientific control. This is not surprising, since tinning is an old trade and one in which skilful manipulation is still necessary, even when facilities for scientific control are available. As a result, the process has been neglected by research workers, and has undergone little change over a considerable period of time.

Outline of the Process

Articles to be tinned by hot-dipping are first carefully cleaned and then dipped into the molten tin bath. To maintain the cleanliness of the surface of the article during dipping a flux solution is previously applied to it. After immersion the article is withdrawn, and, when the surplus tin has been drained off, it is allowed to cool. A departure from this basic procedure is made only when articles are too large to immerse in the tin bath, or when it is desired to apply a coating to a portion of the surface only.

The production of a coating by this method involves an alloying of the tin with the basis metal, and the resulting coating consists of two layers. Next to the basis metal is a relatively thin layer of alloy, and above this is a layer of pure or practically pure tin. The alloy layer formed on iron or steel consists essentially of the intermetallic compound $FeSn_2$, whilst that on copper and its alloys consists of the compounds Cu_6Sn_5 and Cu_3Sn.

Construction of Tinning Baths

A tinning bath consists of a steel or cast-iron pot mounted so that it may be heated conveniently by coal, gas, oil or electricity. In the older tinning installations the various pots required are set in a row in brickwork and heated by coal fires. The disadvantage of coal-firing is that even when pyrometers are fitted to the pots, the control of temperature is not easy. It is essential to have a reliable thermometer or pyrometer in each tinning pot and to pay continual attention to the heating so that the recommended temperatures are closely adhered to.

Modern tinning baths are generally made as separate units, and most are gas-heated, though electric heating is being increasingly used for the smaller sizes. Thermostatic control is often provided. It is desirable to provide the baths with hoods and an efficient exhaust system, especially when using grease or sal-ammoniac in the tinning process, as these give off smoke or fumes, and if there is no exhaust system the atmosphere in the shop is seriously polluted.

Some difference of opinion exists as to the material of which the pots should be made. The usual practice is to construct them of welded mild-steel plate, but cast iron is preferred by some tinners, as it is considered to prolong the life of the pot by reducing the rate of attack on it by the molten tin. No figures are available for the rate at which tin reacts with pots of different materials, but it may be said that under normal conditions the attack is very slow indeed. Even though the inside of the pot becomes tinned, there is generally little further action on it, whether made of steel or cast iron. There are isolated instances of the rapid contamination of tin by iron, but usually, although the pot may be suspected, the trouble is due to other causes. In order to keep the attack on the pot to a minimum, the heating should be as uniformly distributed as possible. If all the heat is concentrated on a small area of the pot, the interaction of the tin and iron at this point may be considerably accelerated. It is generally considered that this increase in the rate of reaction occurs above 496 deg. C., at which temperature the compound $FeSn_2$ is involved in a peritectic reaction.

A disadvantage of cast iron is its liability to crack, and when it is used particular care should be taken to distribute the heating uniformly. The pot should be heated on the sides as well as the bottom, so that when starting up from cold the melting of the tin round the sides will relieve the pressure set up as the tin melts at the bottom. This precaution is desirable also with steel pots, although they are not liable to cracking. If a considerable bulk of tin melts at the bottom, while the sides and top remain solid, a high pressure is produced by the expansion due to melting, and when the top layer finally melts or gives way, liquid tin may be blown out of the pot with some force.

Fluxes for Hot-Tinning

Fluxes are used in hot-tinning in two different ways. A solution of a flux in water is used for dipping articles before they are immersed in the molten tin, and a layer of molten flux is generally used as a cover for the tin bath, in order to keep its surface free from oxidation.

The flux generally used as a preliminary dip is an aqueous solution of zinc chloride. As the article, wet with flux, is immersed in the tin bath, the surplus water boils off and the zinc chloride melts. The molten salt reacts with the surface of the metal being tinned, and removes films of oxide so that it is perfectly clean at the moment when it comes into contact with the tin. It is generally considered that the action of the zinc chloride is due to the liberation of a little hydrochloric acid, formed by interaction of the chloride with the water remaining in it. The flux also prevents spitting of the tin when the wet articles are immersed in it; the solution froths when it comes into contact with the molten tin, and the evolution of steam is much less violent than with plain water.

Since it is in the molten condition that the flux exerts its action, it is desirable that it should melt rapidly and be as fluid as possible at the tinning temperature. Additions of other salts are often made to the zinc chloride, largely with the object of lowering the melting point and increasing the fluidity. The most common addition is ammonium chloride (sal-ammoniac), which forms with zinc chloride a flux of appreciably lower melting point. A suitable flux for general purposes is a solution containing 3 lbs. zinc chloride and 5 ozs. ammonium chloride per gall.

Zinc chloride may be purchased as a solid and dissolved in water, but is often made up as "killed spirit" by dissolving metallic zinc in commercial hydrochloric acid. The zinc is added to the cold acid until no more is dissolved, and the solution is allowed to stand over-night in contact with more zinc; it is then decanted off or strained, and ammonium chloride added in the proportion of 5 ozs. per gall. An earthenware or glass vessel is used to contain the flux during preparation and use, since in an iron tank the flux becomes contaminated with iron.

Numerous proprietary tinning fluxes, based upon zinc chloride and containing ammonium chloride and other salts, are also available. They may be obtained in solid form or as aqueous solutions, and are preferred by many tinners since they save a certain amount of trouble. Some of the special mixtures are claimed to offer advantages as regards their consistency in the molten condition, and general ease of working.

The flux used as a covering layer on the top of the tinning bath is of the same type as that used as a preliminary dip. It is most convenient to employ the flux in solid form (zinc chloride with 10 per cent. of ammonium chloride) for this purpose, allowing it to melt before tinning is commenced. It is also possible to use the solution by pouring it on carefully and allowing the water to boil off, but this is not recommended, since it pollutes the atmosphere of the tinning shop with acid fumes and a fine spray of flux.

The Tinning Operation

Tinning may be carried out with either one or two pots of tin, according to the quality of finish required. For the best results two pots are used, the first being covered with a layer of molten flux and the second with tallow or palm oil. When only one pot is used, it is always covered with flux. The advantages of using two pots are that the tin in the second may be kept free from iron contamination, and that any flux adhering to the articles on with-

drawal from the first bath is removed by the second dipping. In this way a smoother and cleaner finish is obtained. The tallow or palm oil on the second pot keeps the surface of the tin clean and free from dross, and any grease sticking to the articles can easily be cleaned off. Moreover, the presence of slight greasiness on the surface of the tinned articles assists in preserving their bright finish during storage and in preventing rusting.

The articles are taken one at a time from the cold-water storage vat, dipped into flux and immersed in the first tin bath, which is covered with about ¼ in. of molten flux. Care is taken not to immerse them too rapidly, since the sudden evaporation of the water would cause splashes of flux and tin to be blown out of the bath. On the other hand, the rate of immersion should not be very slow, as it is desirable that the surface of the article should still be wet as it comes into contact with the molten flux. The time of immersion should be sufficient to allow the article to reach the temperature of the molten tin. This naturally depends upon its thickness, and varies from a second or two for thin sheet metal articles to a minute or more in the case of large articles such as milk churns. It is desirable that the bulk of tin in the pot should be large in proportion to the weight of the articles being tinned, so that the immersion of the cold stock does not chill the bath seriously. It is very difficult to get a good finish free from adhering dross when working in a pot only just large enough to accommodate the articles to be tinned. In a larger pot manipulation is considerably simplified.

When the article has been immersed for a suitable time it is withdrawn, and, if a second dip is not to be carried out, particular care is taken to avoid adherence of flux or dross. It is found that this is facilitated by pulling the article through the surface of the bath with a jerk. The surplus tin is then drained off, this operation being described more fully later. When a second pot is used, the article is immediately transferred to it before solidification of the coating begins. This pot may be completely covered with a layer of tallow when it is intended to drain off the surplus tin subsequently in a hot oil bath. The time of immersion of articles in the second bath may be very brief, since they are already hot and coated with tin from the first bath.

A good deal of practice in handling the articles is necessary in order to obtain the cleanest results. Where possible, it is better to use hooks than tongs, but, of course, the latter are essential for many types of work. When tongs are used, it is advantageous to change the point at which they grip the work during tinning, otherwise an untinned patch may result.

The coverings of flux and tallow on the baths do not remain in good working condition indefinitely. A molten zinc chloride flux does not work efficiently unless it contains some water, which is often lost more rapidly by evaporation than it is supplied by the wet articles being tinned. It also tends to lose by volatilisation a part of any ammonium chloride it may contain. If the surface of the flux begins to form a crust, it may be improved by sprinkling a little ammonium chloride on it, and applying water in a fine spray; eventually, however, it must be skimmed off and replaced. The tallow on the second bath thickens and loses in time its power of keeping the surface of the tin free from dross. It must then be replaced. Although tallow is generally preferred by tinners, palm oil works in the same way, and may also be used. It has the disadvantage that it gives off a rather more unpleasant smoke, and if the bath is accidentally overheated, palm oil is more likely to discolour the tinned articles.

(To be continued.)

Determination of Carbon in Low-Carbon Iron and Iron Alloys*

By L. A. Wooten.

The determination of carbon in low-carbon iron and steel presents difficulties not easily overcome by the conventionel carbon combustion method. The low-pressure combustion method applied to the problem has been developed into a high-precision method.[1]

The method developed consists of the combustion of the sample in an all-glass apparatus, the collection of the carbon dioxide by condensation in a liquid nitrogen trap, and, after pumping out the excess oxygen, the determination of the carbon dioxide by a vapour-pressure measurement in a standard volume. The sample, contained in a ceramic crucible, which is fitted into a platinum crucible is heated by means of a high-frequency induction furnace, the outside platinum crucible serving as a heating element.

Yensen[2] and Ziegler[3] have described somewhat similar methods for the determination of carbon by the vapour-pressure method, but they

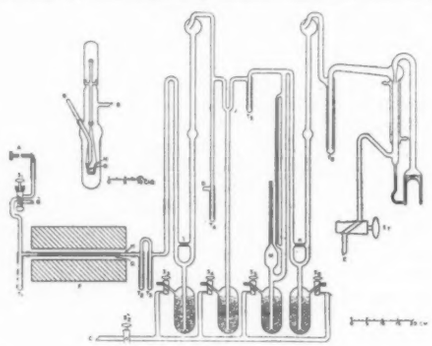

Fig. 1.—Apparatus for Determination of Carbon by Low-Pressure Combustion Method.

A—Flexible copper tube with copper-to-glass seal. *B* and *C*—Outlets to oil pump. *E*—Outlet to oil pump. T_1–T_5—Traps. *F*—Electric furnace. *G*—Palladium catalyst on asbestos. *H*—Clear quartz tube. *I*, *J*, *K*—Mercury cut-offs. *M*—McLeod gauge. S_1—S_7—Stopcocks. *N*—Platinum crucible. *O*—Magnesia crucible.

did not employ high-frequency heating, hence could not use an all-glass system.

The apparatus developed for the determination of carbon is shown in Fig. 1. It consists essentially of a purification system a combustion chamber, and an analysis system, connected to a mercury diffusion pump backed by an oil pump. The oxygen, admitted at A through a flexible copper tubing, first passes through a liquid nitrogen trap, then over a palladium catalyst at 1,000 deg. C., and finally through two more traps at liquid nitrogen temperature before being admitted to the combustion chamber. The capillary by-pass in cut-off I is a device for admitting oxygen at a relatively high pressure of about 16 cm. to the evacuated system. The capillary at K serves a similar purpose in exhausting the excess oxygen. M is a McLeod gauge. The combustion chamber is sealed on at D and is shown in detail in the upper left of Fig. 1. It consists of an E. J. Pyrex glass tube in which is suspended co-axially a platinum crucible which contains the refractory crucible. The sample, in the form of millings or thin turnings, is introduced into the refractory crucible O, through the side tube Q. The platinum crucible is of standard form with reinforced rim of approximately 15-ml. capacity. The refractory crucible used is an alumina or magnesia crucible supplied by Norton Company. The blank on this crucible is readily reduced to a very low constant value by prefiring in oxygen.

The oxygen is purified by liquefying approximately 10 ml. in trap T_1 and then evaporating a portion of this and recondensing it in traps T_2 and T_3. These traps collect any oxidation products formed by passing the oxygen over the palladium catalyst, and they also hold the liquid oxygen until ready to be admitted to the system. At liquid nitrogen temperature the vapour pressure of oxygen is approximately 16 cm., so that it is possible to hold a supply of pure oxygen in trap T_3 while evacuating and outgassing the analysis and combustion systems. The mercury cut-off at 1 is employed as a manometer. An analysis is run as follows: Cut-off K is raised and cut-off I is lowered by manipulating stopcocks 3 and 6, allowing the oxygen at first to pass through the capillary at I and bubble up through the mercury column. After the pressure in the purification and analysis system has equalised, cut-off I is closed and the platinum crucible heated by high-frequency induced current to a temperature of 1,100 deg. C. Heating is continued for 15 to 20 mins. to ensure complete combustion. Prior to burning the sample, a liquid nitrogen bath is placed on trap T_5 and a dry ice-acetone bath on trap T_4. The carbon dioxide obtained is condensed in trap T_5, the excess oxygen is pumped from the system, and the cut-off J is raised. The carbon dioxide is then allowed to evaporate and attain thermal equilibrium, and a vapour-pressure measurement is made. Knowing the volume of the system and the vapour pressure, the carbon content of the sample is computed.

The precision of this method has been found to be plus or minus 10 per cent. on samples containing 0.001 per cent. carbon. The method is applicable not only to low-carbon iron and iron alloys but also to higher carbon samples where only a very limited sample is available. For example, the method has been applied to the determination of carbon in samples of vacuum tube filament core materials weighing only a few milligrams.

* Extracted from an article entitled "Micro-Gas Analyses Methods and their Application to Research" which appeared in the January issue of the A.S.T.M. Bulletin.

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[1] Wooten and Guldner, to be published in "Industrial and Engineering Chemistry," Analytical Edition.
[2] Yensen, Trans. Am. Electrochemical Soc., vol. 37, p. 277 (1920).
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Notes from the Branches

Lancashire—At last month's meeting of the Lancashire Branch of the Institute of British Foundrymen, held in Manchester, Mr. W. Holland (Branch-President) referred to the recent death of Mr. R. A. Miles, who was, he said, more generally known to the members as "Dick" Miles. The Institute had lost one of its staunchest supporters. Miles would ever be remembered with affection, and he had always been willing to help members by his valuable advice and wide knowledge of all matters connected with the foundry industry.

The members stood in silence for a short period.

East Anglian Section—The next meeting will be held at the Central Library, Ipswich, on April 19, at 3.30 p.m., when Mr. J. King is to present a Paper on "Some Factors Influencing the Production of High Grade Iron."

International Combustion, Limited

The annual meeting of International Combustion, Limited, was held on March 4. Mr. G. R. T. Taylor (chairman) said that all the company's facilities had been placed at the disposal of the Services, and their products were of the first national importance. They had undertaken schemes for manufacturing certain urgent Government requirements. The works were employed at full pressure.

Surface Treatment of Magnesium Alloys*

By H. W SCHMIDT, W. H. GROSS and H. K. DELONG

The importance of chemical treatments for both ferrous and non-ferrous metals is gaining increasing recognition. Paint-base qualities, protection against corrosion, wear resistance, and decoration are the prime purposes for which these treatments are designed. Some chemical treatments may provide the metal surface with only one of these qualities, while others may afford a combination of two or more. Of these characteristics, protection against corrosion and paint-base qualities may be considered the most important when magnesium alloys are concerned. Corrosion resistance of a chemical coating is its ability to protect the metal from attack by corrosive influences such as the atmosphere, salt water or other corrosive environments.

Generally speaking, a chemical treatment which protects the metal from corrosive influences will offer at least some improvement in paint adhesion. Wear resistance and decorative effects may be achieved by some treatment methods. The demand for these latter treatments is somewhat limited, but in those cases where painting is not permissible a pleasing decorative effect with appreciable wear resistance and protection may be attained.

A few brief comments on corrosion of magnesium will present a proper background for discussion of other but related subjects. Numerous tests and industrial uses of magnesium have proved that this metal is remarkably resistant to ordinary atmospheric corrosion conditions. In the case of a casting which has been continuously exposed to industrial atmosphere at Midland, Michigan, for 15 years, the formation of a thin, uniform grey film is the only change that has occurred since this casting was first placed on the exposure rack. Fig. 1 is a photograph of painted magnesium alloy panels removed after practically one year of tidewater test at Wilmington, North Carolina. The excellent condition of the metal even where paint failure has occurred proves that magnesium alloys may be ranked among the stable industrial metals. Here also is clearly demonstrated the importance of chemical treatment mentioned in the opening paragraph. Panels 42 and 55 were chemically treated prior to painting. Panels 48 and 61 were given an identical painting schedule, but the metal had not been chemically treated. The value of proper chemical treatment prior to painting is clearly demonstrated by this test.

Cleaning

One of the most important steps in the application of a chemical treatment is cleaning. Proper cleaning demands that all foreign matter be completely removed from the surface of the metal to be chemically treated. Not only must dirt and oil be removed, but oxides and other impurities as well. The surface should be left in such a condition that it can form a continuous union with the chemical coating to be applied. A thoroughly cleaned surface will be completely wetted with a film of water when dipped in clean cold water. A break in the water film is a definite indication that foreign matter still exists and the surface is not thoroughly cleaned.

The removal of oxides from the surface of magnesium is best accomplished by acid pickling, as the oxide will dissolve in most common acids. Chromic acid has been found to be the most satisfactory acid to use where no dimensional changes can be tolerated. This particular acid does not attack magnesium alloy as would occur by sulphuric or nitric acid pickling. Chromic acid may be used on machined parts without a dimensional loss being incurred. The chromic acid cleaning bath is made up of chromic acid (CrO_3) 1½ lbs., and water (distilled) to make 1 gall. The parts to be cleaned are immersed for 1 to 5 mins. in this bath, which is operated at 90 to 100 deg. C.

Tap water may be used in compounding this cleaning bath, but must be fairly free from chlorides. If appreciable amounts of chloride ions are present the bath functions as a chemical treatment depositing an insoluble film of a different type of oxide on the surface, which is detrimental to subsequent chemical treatment.

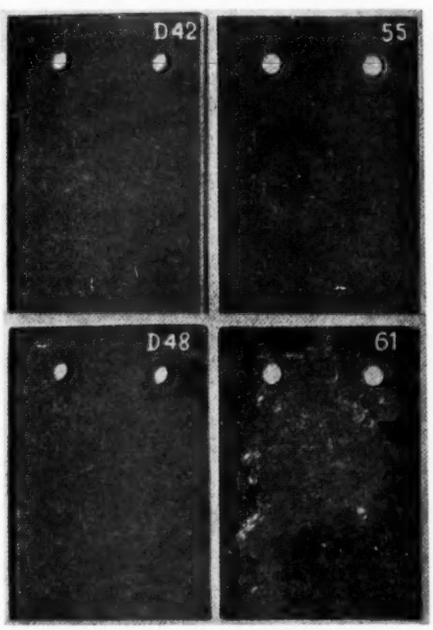

FIG. 1.—DOWMETAL PANELS AFTER 6 MONTHS' TIDEWATER TEST, SHOWING VALUE OF CHEMICAL TREATMENT BEFORE PAINTING.

Tap water which has a high soluble chloride content can be used providing a small amount (usually 0.1 per cent.) of silver nitrate is added to precipitate the excess chlorides. The silver nitrate is first dissolved in a small amount of water and then added to the chromic acid bath.

Oxide, dirt, etc., may also be removed by mechanical cleaning, such as wire-brushing, sanding, sand-blasting, and shot-blasting. Sand-blasting or shot-blasting, while being a very economical and efficient method of surface cleaning, is very undesirable on magnesium if maximum corrosion resistance to salt water or salt atmosphere be desired. Magnesium is very sensitive to cleaning methods of this type. This acceleration of corrosion is due to contamination of the surface.

Sand-blasting or shot-blasting should always be followed by pickling in strong acid such as nitric or sulphuric acid so as to remove the superficial blasted layer. The corrosive effects of blasting can be practically eliminated by the removal of about 0.002 in. of metal per surface, depending on the method, as demonstrated in Table I. A 10- to 15-sec. pickle in a solution containing by volume 8 parts of concentrated nitrid acid, 2 parts of concentrated sulphuric acid, and 90 quarts of water is satisfactory. This acid pickle should always be applied before any machining operation, as the amount of metal removed is likely to exceed machined dimensional tolerances. It is quite safe, however, to pickle rough, unmachined castings and heavy sections.

Magnesium may be degreased by any of the common methods of alkaline or solvent cleaning. Cleaners of the strongly alkaline type, such as commonly used on steel, are the most satisfactory. The alkaline cleaning procedure may be by boiling or by cathodic electrolytic cleaning in the alkaline cleaning solution.

TABLE I.—*Effect of Pickling on Sand-blasted Magnesium Alloy Surfaces.*

Treatment.	Rating.
Sand-blast	Very poor
Sand-blast plus acid pickle	Fair
Sand-blast plus chrome-pickle	Fair
Sand-blast plus acid pickle plus chrome-pickle	Fair +
Sand-blast plus acid pickle plus HF dichromate	Good

NOTE.—Acid pickle .. 15 sec. in 8 per cent. HNO_3 + 2 per cent. H_2SO_4.
Paint schedule .. 2 coats P-27 zinc chromate primer.
2 coats V-10 varnish + 1.5 lbs. per gall. aluminium.
Test—1 week in 20 per cent. salt spray at 95 deg. F.

A satisfactory degreasing solution for magnesium which may be used either as a boiling or electrolytic cleaner is made as follows: Trisodium phosphate, 4 ozs.; sodium carbonate, 4 ozs., and water to make 1 gall. This cleaning solution is operated at 90 to 100 deg. C. When used as a dip cleaner some form of agitation should be used if the bath is operated below the boiling point. The time required for cleaning is from 5 to 15 min., depending, of course, on the nature and amount of oil or grease to be removed.

As an electrolytic cleaner the solution may be operated below the boiling point without the necessity of agitation, as the agitation is afforded by gas evolution on the surface of the work. The magnesium part is made the cathode in the cleaning solution and a direct current of 10 to 20 amps. per sq. ft. of surface is applied. The only advantage in electrolytic cleaning is that the desired oil or grease removal is effected in a shorter time. Usually 1 to 3 min. are required for complete removal.

Solvent cleaning does have value as a cleaning step prior to alkaline cleaning in instances where heavy films of oil or grease are present on the part, but should always be followed by some form of alkaline cleaning for best results.

Oxide Coatings

One of the earliest protective chemical coatings for magnesium and its alloys consisted of the hydroxide of magnesium. It has long been observed that, if left to natural weathering, magnesium acquired a layer of oxide, hydroxide, or carbonate that protected it from further attack. An early method of artificially producing this hydroxide coating was accomplished by Backer,[1] who subjected magnesium to the action of steam at elevated temperatures and pressure.

Another somewhat similar method was that of Pieper,[2] who introduced oxidising agents into a bath designed to operate above boiling temperature. Although relatively thick abrasion resistant and protective coatings were formed by these methods, it was not until the comparatively recent development of the caustic-pressure treatment, or commonly called Dow No. 6

* Extracts from a Paper presented before the twenty-second annual convention of the American Society for Metals, held in Cleveland. The authors are associated with the Dow Chemical Company, Midland, Mich.

treatment, that coatings of this type have shown much promise for commercial application.

The caustic-pressure treatment is applied in an autoclave. The process consists of immersing the articles to be coated in an aqueous solution containing 10 per cent. sodium hydroxide (caustic soda). The autoclave is closed and heated to 200 deg. C., which generates a pressure of approximately 225 lbs. per sq. in. The treatment at this pressure is continued for one to five minutes, at which time the pressure is released by cooling the solution in the autoclave to below 100 deg. C. and the articles are then removed. Attractive coloured coatings can be produced by including the proper organic dyes in the treating bath or by a subsequent immersion in dye solutions.

The coating produced on magnesium and its alloys by the caustic-pressure treatment is harder than the original metallic surface, being analogous to the anodic coating on aluminium in this respect. The coating also offers appreciable protection against corrosion by salt water. The paint base qualities of the coating are inferior to those inherent in other treatments described, but satisfactory adhesion is obtained on cast surfaces where the natural roughness of the surfaces provides good mechanical anchorage for paint. The comparative protective value of caustic-pressure coatings and other chemical treatments is given in Table II.

Table II.—*Comparison of Various Chemical Treatments on Magnesium Alloys.*

Treatment.	Paint base qualities.				
	Relative abrasion resistance.	Protective value in salt water. H alloy cast.	Paint adhesion values—atmospheric exposure		
			H alloy cast.	F alloy wrought.	M alloy wrought.
Chrome-pickle	Poor	Fair +	Good	Good	Fair +
Alkaline-dichromate	Fair	Fair	Good	Fair +	—
Chrome alum-dichromate	Fair	Fair to fair +	Fair + to good	Fair	Fair
Caustic-pressure	Very good	Fair + to good	Fair + to good	Fair —	Fair —
HF-dichromate	Fair	Very good	Good	Fair +	—
HF-alkaline-dichromate	Fair	Good	Good	Fair +	—
Galvanic-anodise	Fair	Good	Good	Fair +	Fair +
Chrome-sulphate	Poor	Fair —	Fair to good	Fair	Fair
Modified PT-13 b (HF + PT-13b)	Fair	Fair + to good	Good	Fair +	Fair —
Selenium treatment	Fair	Fair —	Good	Fair to Fair +	Fair
French vitrification (Frasch)	Fair + to good	Fair +	Fair +	Poor	Poor
Alum-dichromate	Fair —	Poor	Fair + to good	Fair —	—
Phosphate treatment	Fair to fair +	Poor	Good	Fair + to good	Poor
Chrome-phosphate	Fair	Poor	Good	Fair	Fair —
Backer treatment	Fair +	Fair	Fair	Poor	Poor
Pieper treatment	Fair +	Fair	Fair +	Poor	Poor
No treatment	—	Very poor	Poor	Very poor	Very poor

Note.—A dash indicates that treatment is not suitable for this particular alloy.

Another oxide process, although not used in America, deserves mention because of the recent publicity it has received. This is the so-called Frasch, or French vitrification process.[3] The essential steps consist of first applying an oxide layer on a magnesium alloy surface by anodic oxidation in a bath containing 5 to 20 per cent. NaOH + 2 to 3 per cent. Na_2SiO_3 + 2 to 3 per cent. $Al_2(SiO_3)_3$ + 0.1 to 0.2 per cent. $KMnO_4$, followed by an immersion treatment in a solution containing 5 to 30 per cent. Na_2SiO_3 + 3 to 4 per cent. NaOH + 1 to 2 per cent. $Al_2(SiO_3)_3$, which provides the so-called "vitrification" of the coating. Although only a limited number of tests have been made by the authors, these have failed to demonstrate that the process is equivalent in protective value to the best treatments available in the United States.

Phosphate Coatings

Attempts to produce insoluble compounds on magnesium surfaces would not have been complete without the production of an insoluble magnesium phosphate layer. This was first accomplished by Zimmerman[4] by the immersion of a magnesium alloy in a 1 per cent. H_3PO_4 solution for one hour. Burdick[5] improved on this method by a treatment consisting of 30 min. immersion at 50 deg. C. in a solution containing 1 lb. of 85 per cent. phosphoric acid and 3 ozs. of magnesium oxide per gall. This process was in commercial use for some time.

A still further improvement in the protective value of the phosphate treatment was made possible by the addition of sodium dichromate. The chrome-phosphate, or Dow No. 2, treatment,[6] as this new process was called, replaced the older treatment. This treatment consists in boiling for 40 min. in a solution containing 10 per cent. each of NaH_2PO_4 and $Na_2Cr_2O_7$ and still finds some application in the finishing of magnesium alloy parts. The most recent modification of the phosphate type coating for magnesium alloys was made when Buzzard and Wilson[7] found that parts could be treated anodically in the sodium dichromate-phosphate bath. This treatment is now popularly known as the PT-13 and is described in Navy Department Bureau of Aeronautics Specification. Considerable improvement has been made in the original process by including a preliminary dip in hydrofluoric acid solution as in the case of the HF-alkaline-dichromate and the HF-dichromate treatments described elsewhere in this Paper. Comparative data showing the relative protective and paint base values of the chrome-phosphate and the PT-13 processes are given in Table II.

Chrome-Pickle

One of the most widely used chemical treatments is a dip in solutions containing nitric acid and dichromate, represented in America by the acid dichromate dip, or the chrome-pickle treatment, also known as Dow No. 1 treatment. Producers of magnesium alloys make greatest use of this treatment. This accounts for the characteristic yellowish iridescent colour of magnesium alloy castings, extrusions, sheet and other forms. The coating serves to protect parts during shipment, storage and machining. In most cases, the aircraft industry in particular, magnesium alloy parts are treated by other processes after machining or fabrication.

Generally, the process consists of a 15-sec. to 2-min. dip, at room temperature, in a water solution containing 1.5 lbs. of sodium or potassium dichromate and 1.5 pints of concentrated nitric acid per gall., followed by rinsing in cold and then hot water. This treatment not only functions to provide a passive film on the metal, but also etches the surface so as to provide better anchorage for subsequent paint coatings. This etching action removes up to 0.0006 in. of metal per surface, and therefore somewhat limits the use of this treatment on machined surfaces, particularly where the dimensional change must be kept at a minimum.

The chrome-pickle treatment produces a visible colour and a lustre ranging from matte to bright. The colour, lustre and etch will vary with the age of the solution and with the composition and heat-treatment of the alloy. All of these bear a definite relationship to the paint adhesion offered by the treatment. The most desirable is a matte, grey to yellow-red iridescent coating which shows a network or pebbled etch under the microscope. The intensity of the colour largely is dependent on the time the article is exposed to the air in the interval between removal from the chrome-pickle solution and immersion in water. At least a 5-sec. period of exposure to the air should be allowed to ensure a full uniform shade. Too long a time in air will form a loose powder on the surface. Addition of small quantities of sodium dichromate to the final wash water has been suggested to improve the colour of the coating, but this practice has been found detrimental to paint adhesion, although some improvement has been shown in the protective value of the coating.

With magnesium alloys containing 10 to 12 per cent. total alloy content, and particularly die-castings of these alloys, it has been found desirable to operate the solution at 50 to 60 deg. C. A grey to black powdery deposit of Mg_3Al_2 compound is formed on the surface of alloys of this type when the solution is operated at room temperature. Contrary to expectation, the presence of small quantities of this powder on the surface is not detrimental to paint adhesion, but its presence is unattractive. Treatment in a hot solution effects a dissolution of the Mg_3Al_2 compound as it is formed, resulting in a powder-free surface. The time of treatment in the hot solution is usually 10 to 15 secs. Magnesium-manganese alloys do not attain as good a coating as the aluminium-containing alloys, and it is necessary to use only a very fresh solution to obtain satisfactory results. The galvanic anodise treatment described elsewhere in this Paper is preferred for magnesium-manganese alloys.

The chrome-pickle treatment may also be applied by brushing. Parts too large to immerse may be treated in this manner. The parts are well brushed with a generous amount of the fresh solution and the brushing operation is followed by a thorough washing with water. The coating is less uniform in colour than that produced by the dip process, but it has been found that the coating thus formed is equally good as a paint base both in protective value and paint adhesion qualities.

Selenium Treatment

Another process for providing surface protection and a base for subsequent paint coatings is known as the selenium treatment.[8] This treatment has not been used to any extent in America, which may be due in part to the comparatively excessive cost of the basic material necessary in the treatment bath.

The coating is applied to magnesium by several methods. One method which is suitable for magnesium-aluminium-manganese or magnesium-aluminium-manganese-zinc alloys consists in the immersion of the parts for 5 to 15 min. at room temperature in a water solution containing 10 per cent. selenium dioxide and 0.5 per cent. sodium chloride. The parts are then removed, washed well in running water and dried.

A second method of application which is suitable for magnesium-manganese alloys may be carried out in a bath containing 2 per cent. sodium selenite and 6 ml. ortho-phosphoric acid per litre. The coating is applied in this bath by immersing the part for 15 min. at room tem-

perature. The parts are then removed from the bath and allowed to drain until dry.

An alternative method of application is also suitable for magnesium-manganese alloys. The parts are immersed for 30 secs. in a 1 per cent. solution of chromic acid at 90 deg. C., washed, and immersed in a 10 per cent. aqueous selenium dioxide solution at room temperature for 30 to 60 secs. The film is allowed to dry and is then washed in water and allowed to dry once more. The colour of the selenium film on magnesium is reddish brown.

Sulphate-Dichromate Treatments

The sulphate-dichromate treatments have been found very useful, particularly on magnesium parts which are machined to very fine tolerances. Very little or no change in dimension results from these treatments and in some cases very substantial improvements are made in the resistance of the metal to corrosive influences by coatings of this type. This is particularly true of the HF-alkaline-dichromate treatment which will be described later.

One of the first treatments of this type of commercial value was the alum-dichromate[7] treatment developed by Sutton and LeBrocq. The following solution is required:—1.5 per cent. potassium dichromate, 1.0 per cent. potassium alum and 0.5 per cent. sodium hydroxide. This is prepared by making a mixed solution of high concentration of alum and caustic soda and adding the dichromate also in the form of a strong solution. The degree of concentration of the solutions employed should be such that when the mixture is diluted with water the required strength is obtained. The final solution is heated to 100 deg. C. and the parts immersed for 6 hrs. and gently boiled. Water is added from time to time to replace that lost by evaporation. The parts are then removed from the bath and rinsed in water and dried.

This treatment was later modified so as to shorten the time required for application. This modified treatment is known as the alkaline-dichromate[10] or Dow No. 3 treatment. The shortening of the time did much to increase the popularity of this treatment. The solution required contains:—3.0 per cent. ammonium sulphate, 1.5 per cent. ammonium dichromate, 1.5 per cent. potassium dichromate and 0.5 per cent. ammonia (sp. gr. 0.880). The solution is heated to 100 deg. C. and the parts immersed and boiled briskly for 30 to 45 min. The parts are then washed in water and dried. Water is added to the bath from time to time to replace that lost by evaporation. This bath maintains its efficiency over fairly long periods of use. The treatment produces a brown to dark grey to black coating on the metal. The colour of the coating or decorative effect is dependent on the composition and state of the alloy and pre-treatment or cleaning. The colour, however, has no direct bearing on the paint base quality or protective value of the treatment.

A still further modified and improved method of applying the alkaline-dichromate treatment has been developed and is now known as the HF-alkaline-dichromate or Dow No. 8 treatment. This treatment provides a distinct improvement in protective value over the alum-dichromate or alkaline-dichromate treatments. The No. 8 treatment effects no dimensional change on magnesium and may be used on parts machined to close tolerances. It consists of three steps applied as follows, after proper surface cleaning and degreasing as described previously:—

Step 1.—Immerse parts for 5 min. in a water solution containing 15 to 20 per cent. hydrofluoric acid (HF) at room temperature. This bath may be prepared by diluting one volume of technical grade 48 to 52 per cent. HF with two volumes water. The parts are then washed thoroughly in cold running water.

Step 2.—Boil parts for at least 45 min. in a water solution containing the following ingredients:—3.0 per cent. ammonium sulphate $(NH_4)_2SO_4$; 3.0 per cent. sodium dichromate $Na_2Cr_2O_7 \cdot 2H_2O$; and 0.25 per cent. ammonia (sp. gr. 0.880) NH_4OH. The original solution level is maintained by the addition of water from time to time to replace that lost by evaporation. After treatment the parts are washed thoroughly in cold running water.

Step 3.—Boil for at least 5 min. in a water solution containing 1 per cent. by weight of arsenous oxide (As_2O_3). This solution can be readily prepared by adding arsenous oxide to water in the ratio of 1.333 ozs. per gall. The original solution level is maintained by the addition of water to replace that lost by evaporation. After this treatment, which is the final step in the treating procedure, the parts are washed thoroughly in cold running water, followed by a dip in hot water to facilitate drying. Properly applied, the colour of the coating will vary from dark brown to black. Time of treatment, condition of the treatment bath in Step 2, and the alloy composition will influence the colour of the coating.

Galvanic Anodise

A further modification of the HF-alkaline-dichromate treatment is known as galvanic anodise, or Dow No. 9 treatment, which is particularly useful on magnesium alloys of the magnesium-manganese type, although it may be satisfactorily employed on all types of alloys. The protection against salt water and the uniformity of the coating obtained is superior to that provided by the chrome-pickle treatment. The paint adhesion properties of this coating are also superior to the chrome-pickle treatment on magnesium-manganese alloys. The colour of the coating is black. The coating is applied in a two-step procedure, as follows:—

(1) Immerse parts for 5 min. in a water solution containing 15 to 20 per cent. hydrofluoric acid at room temperature. The parts are then removed and washed thoroughly in cold running water. This bath may be satisfactorily made by diluting one volume of 48 to 52 per cent. hydrofluoric acid with two volumes of water.

(2) The parts are then immersed and galvanically anodised in the following bath:—3 per cent. ammonium sulphate, 3 per cent. sodium dichromate, and 0.25 per cent. ammonia (sp. gr. 0.880). It should be noted that the above solution is the same as that used in the HF-alkaline-dichromate treatment.

An iron or steel tank is used to contain this bath, or iron or steel cathode plates may be used if the tank is made of non-metallic material. The magnesium parts are electrically connected with the iron or steel tank or cathode plates, care being taken that the work does not make contact with the tank except by an external connection. An ammeter and rheostat should be in the electrical circuit. A current density of at least 2 amps. per sq. ft. of anode area must be maintained and the treatment continued for 15 to 30 min. The current should not exceed 10 amps. per sq. ft. at any time or a loose powdery coating will result. In general, the time of treatment is proportional to the current density used, and must be long enough to produce a uniform black coating. The bath may be operated at room temperature, but increasing the temperature up to 65 deg. C. will shorten the time of treatment.

Chrome-Sulphate

The chrome-sulphate treatment, also known as Dow No. 11 treatment, is a speciality treatment that, while it can be classed generally in the sulphate-dichromate type of treatment, actually stands alone and does not trace its development directly back to some earlier treatments. The treatment consists of an immersion for 15 mins. in an aqueous solution at 70 deg. C., containing 8 ozs. $MgSO_4$ per gall., and 6 ozs. $Na_2Cr_2O_7$ per gall. The process is especially effective for producing a uniform coating on magnesium-manganese alloys. The galvanic anodise process described in this Paper is more protective and superior for general usage, but the chrome-sulphate treatment is necessary on magnesium-manganese alloys where low electrical resistance is requisite. Aircraft conduit and fittings are examples of a typical application. The chrome-pickle treatment may also be used where low electrical resistance is required.

Chrome-Alum Treatment

The chrome-alum, or Dow No. 4, treatment, like the chrome-sulphate treatment described above, is related to the sulphate-dichromate treatments, and is a speciality treatment designed for a specific purpose. In this case the treatment is used where it is desired to provide magnesium alloy die-castings with a black decorative finish that also serves as a base for paint. The chrome-alum coating is less protective than the HF-alkaline-dichromate coating which replaces it when maximum salt water resistance is required.

The chrome-alum treatment is applied by immersing the cleaned parts in a boiling aqueous solution containing 4 ozs. of potassium chrome alum and 13 ozs. of sodium dichromate per gall. The time of treatment necessary to obtain a black colour will range from 2 to 15 min. Properly applied, the coating is black in colour and consists of a smooth compact layer adhering firmly to the surface. More uniform coatings will be obtained if the die-cast surface film is removed by machining, wire-brushing, buffing or sanding.

HF-Dichromate

The HF-dichromate, also known as Dow No. 7 treatment or dichromate process, is one of the more recent developments in the chemical treatments for magnesium alloys. It has long been known that simply boiling in a solution of sodium dichromate would materially improve the resistance of magnesium alloys toward salt water. Boiling in dichromate alone, however, did not afford as much protection as some of the other treatments, such as the alkaline dichromate, chrome-phosphate, and the like. It was discovered that, if the boil in dichromate were preceded by a dip in hydrofluoric acid, the protective value was so increased that it became one of the most protective of the chemical treatments. Data and photographs included in the original Paper demonstrate the superiority of the HF-dichromate treatment.

The application of this treatment consists essentially of two steps applied as follows after proper cleaning:

(1) Immerse the parts for 5 mins. at room temperature in a water solution containing 15 to 20 per cent. by weight of hydrofluoric acid. Wash parts thoroughly in running water and apply Step No. 2 as follows:

(2) Boil the parts for at least 45 mins. in a water solution containing 10 per cent. by weight of sodium dichromate or potassium dichromate. Wash thoroughly in cold water and then in hot water to facilitate drying. The colour of the coating is deep brown. The treatment is not recommended for magnesium-manganese alloys.

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Care of Chipping Hammers*

In the use of pneumatic tools, especially chipping hammers and grinders, where these tools are used in steelworks for production work, there are several important factors affecting their operation and their maintenance: (1) Correct selection of tools for the work to be performed; (2) effective lubrication; (3) renewal of worn parts; (4) complete periodic mechanical inspection of tools to determine their efficiency and when complete overhaul is necessary, and the courage to scrap and replace these tools due to high maintenance or low operating efficiency.

Chipping hammers operate at speeds from 1,800 blows per min. upwards. Lubrication is important because it minimises the wear between the piston and barrel. The best method of lubrication is effected by the installation of a lubricator providing a constant supply of oil during the operating time of the tool and eliminating the necessity of frequently uncoupling the tool from the hose to squirt oil in through the throttle, which at best, is a poor substitute for correct lubrication. Yet still better than the practice of squirting oil into the barrel of the hammer through the nozzle end, which may lubricate the piston and barrel to some extent, but cannot lubricate the valve or heart of the tool. Haphazard, incomplete lubrication left entirely to the discretion of the operator is very little improvement over no lubrication at all.

It is advisable also to use air free from moisture, as wet air is detrimental to the tools because it first forms an emulsion with, and then gradually flushes, the oil from the wearing parts of the hammer, leaving them to operate with little or no film of oil between wearing surfaces.

In most works where chipping hammers are used, and especially in steel foundries, a fine abrasive dust is usually encountered. Due either to the actual operation of the tool or to the operator blowing dust and scale from the work at intervals, this dust gets into the tool and, being abrasive, tends to increase wear. It also mixes with the oil in and around the tool, forming a gum which should be removed.

To keep hammers in the best operating condition and minimise the dust damage where it exists, it is a good plan to soak all hammers, when not in operation, in a bath of two-thirds kerosene and one-third lubricating oil, completely submerging the tool in the bath. This soaking is arranged for every night in some plants—in others only over the week-end. This tends to soften the gum and loosen any scale or foreign matter, so that when the tool is again used this gum being loose, flushes out.

Concerning chipping hammers, the most costly item in the operation is the wages paid to the operator; secondly, the cost of the air to operate the hammer; and, thirdly, the repair cost to maintain the hammer. A hammer low in power and high in air consumption will make just as much noise and within limits hit just as fast as an efficient hammer, but the power or cutting efficiency may be low and the air consumption high—with the result that per pound paid out in labour and the cost of air a productive return of money value is far from being obtained.

An investigation some years ago showed that the average efficient life of a hammer was from two to four years, depending on type of work on which the hammer had been used and the number of shifts worked. Necessary repairs to the hammers such as new pistons, valves, throttle parts, triggers, etc., were applied from time to time due to natural wear and the hammers sent back on the job, but practical works' tests indicated that the hammers were gradually losing their power and operating on increased air consumption as compared to a new hammer.

A representative number of the hammers was sent back to the manufacturer for test to determine the following: (*a*) The cutting power of the hammer as compared to a new one in per cent. (*b*) The air consumption of the hammer as compared to a new one in per cent. (*c*) An estimate of cost completely to recondition the hammer. These figures permitted a determination as to whether the hammer should be reconditioned or scrapped (taking into consideration the time the hammer had been working; *i.e.*, number of months).

From the data obtained it was concluded that if the efficiency was more than 20 per cent. down or the air consumption 20 per cent. up, the hammer was sent for complete overhaul or scrapped. Then the author took into consideration the cost to repair the hammer, and if in conjunction with the low efficiency and high air consumption this cost ran 30 per cent. or over, the hammer was scrapped and new ones purchased. The author found that it did not pay to spend too much money per hammer for reconditioning, because while the valve and box could be renewed, and the barrel and handle completely reconditioned, it was impossible to relieve the fatigue set up in the threads of the barrel and the handle where they screw on to each other, this fatigue being a result of the constant vibration of the piston impacting on the chisel. The result of all this was that, after the reconditioning expense and the hammers having been put back on the job, the threads would yield, strip, or the barrel or handle would crack through the threads, and the hammer then became useless.

* From an article by Mr. M. J. Conway entitled "Maintenance of Air-Operated Tools" in "Iron and Steel Engineer."

New Labour Force for Industry

CENTRALISATION OF NON-ESSENTIAL PRODUCTION

With the object of releasing labour for war work, the Government has decided on a policy of concentrating the production of consumer goods in fewer factories. The Government is preparing to meet an unprecedented demand for labour in the war industries. To secure this new labour force, there will be a thinning-out of all but vital production. In particular, the Government is concerned with the group of industries manufacturing consumer goods affected by the Limitation of Supplies Orders or by the rationing of raw materials—hosiery, pottery, the major textile industries, boots and shoes, and some others. These industries provide the main sources of factory-trained labour for munitions, and their consumption of imported materials must be kept down to the minimum required to meet essential needs. Their production is to be concentrated in a reduced number of factories working full-time. These factories, it is believed, should be able to produce the output required for Government orders, the greatest practicable export trade, and the minimum needs of the population, while preserving the goodwill of the factories closed down.

In the industries to which the plan applies one factory will do the work of several. Manufacturers whose factories go out of production will not be compensated by the State, but will be credited with the results of the business which they have transferred. Their trade marks will be preserved to the extent of their quota of the combined production. Displaced workers will, as far as possible, be absorbed into war industries in their own neighbourhoods.

Uses of Lithium

Although there has been a large amount of metallurgical work done on lithium and its alloys, the quantity used for this purpose in connection with both the oxidation and alloying is still small. While the lithium-copper alloys are of considerable interest, their production is still on the laboratory scale. Considerable interest is now being shown in lithium and its compounds for producing non-scaling atmospheres in heat-treating furnaces, states C. L. MANTELL in a review of new uses of the minor metals in "Metal Progress."

Nickel Industry in 1940

The International Nickel Company of Canada, Limited, has issued a memorandum on nickel consumption in 1940, in place of the statement which is usually made by Mr. R. C. Stanley, chairman and president of the company. Some brief extracts are appended.

Consumption of nickel in all forms during 1940 showed an increase over that of 1939 [estimated at 240,000,000 lbs.], which was the largest for any year in the life of the industry. The markets for nickel-copper alloy steels are rapidly expanding, particularly in the transportation and petroleum fields, due to their better fatigue properties and improved corrosion resistance. Excellent welding qualities as well as toughness at sub-zero temperatures are factors augmenting the use of low-carbon nickel-alloy steels. There is also increased interest in "S.A.E." standard type steels containing 3½ to 5 per cent. nickel, particularly in the chemical and process industries. A case in point is the large quantities of 5 per cent. nickel steel tubing which have been installed in black liquor evaporators in paper mills.

Pronounced activity in the aircraft industry is bringing about increased use of the high strength, low alloy, heat-treated steels for structural and engine parts. Both automotive and aviation production are adopting nickel-chromium-molybdenum steels for stressed parts machined after heat-treating to over 400 Brinell. This has served to simplify heat treatment and machining practice by eliminating distortion as a factor to be considered and by generally improving dimensional accuracy of the finished parts.

For gears and shafting, widely used in all industries, nickel-alloy steels continue to be specified in increasing quantities. The same is true of bolts, subject to high stresses, and also of numerous heavy forged parts.

Since many sources for high-carbon chromium steel have been cut off, there has been a trend toward the adoption of carburised nickel-molybdenum steel for bearing races. A high carbon nickel-molybdenum steel promises to effect a considerable improvement over materials now in common use for coil and leaf springs.

Special Alloys

A special 45 to 55 per cent. nickel-iron alloy is being largely consumed in the form of sheet. This metal possesses extremely high permeability at low current densities, which fits it admirably for a new type of heat control.

Alloys of 32 to 42 per cent. nickel iron continue to be employed in the low-expansion side of bi-metal for thermostatic work, and have been utilised during the year in a new type of thermometer. For the high expansion part of bi-metal devices, a 22 per cent. nickel alloy is being increasingly used.

Greater aircraft production has resulted in increased orders to steel companies for "aircraft quality" steels, most of which contain nickel. Over two million pounds of "18-8" stainless steel have been used this year by U.S. West Coast aircraft manufacturers alone, chiefly for non-structural parts.

There has been an increased use of quenched-and-tempered nickel-chromium and nickel-molybdenum steels for locomotive rods, pistons, axles and other forged parts to reduce fatigue failures and save weight. A majority of the locomotives built during the year were equipped with nickel steel boilers, firebox plates and rivets.

Castings made of austenitic manganese-nickel steel for frogs and switches installed in Canada at marshalling yards have shown excellent service life.

South African Industry at War*

By A. G. THOMSON

Seldom has an industry been called upon at shorter notice to undertake a task of such responsibility and magnitude as that which faced South African engineers when war broke out. To say that the engineering industry has risen to the occasion is an understatement. It has already accomplished not merely all that was originally hoped for, but a great deal more. Within the period of a few months, engineering works have been converted into efficient munitions factories, and even small jobbing shops have somehow or other been transformed into high precision works playing an indispensable part in South African defence. On account of the limited resources of the Union, it was not anticipated that certain essential articles could be locally produced. To-day, these articles are being manufactured in ever-increasing quantities, and compare very favourably in quality with the products of munition factories in Berlin or the United States.

Initial Difficulties

Fully to appreciate the achievements of the South African engineering industry, it is necessary to have some realisation of the magnitude of the obstacles which had to be overcome. Before discussing specific aspects of munitions production, it is as well, therefore, to consider the general problems involved in the transformation which has so swiftly taken place. More formidable even than such practical difficulties as shortage of skilled workers or delay in the arrival of machinery from overseas, were what might be termed the psychological readjustments which had to be made before munitions production could be successfully tackled. In several important respects the outlook of both managers and men had to be entirely altered, and this revolution was a necessary preliminary to the training of whole staffs in methods of production which were novel to the vast majority of local engineering firms.

In ordinary commercial work, perfection is by no means invariably desired, but in munitions production there is no such thing as "good enough," and the question of cost is relegated to the background. Inevitably there was a considerable amount of heart-burning before this essential principle was clearly understood. Fine tolerances involved the manufacture of high-precision gauges, which were something entirely new to many firms. Formerly a monthly check with callipers and micrometers was in most cases considered to be all that was required.

Jigs and Tools

Directors and managers had thus to be convinced of the necessity of spending several thousand pounds on gauges before a single article could be produced. They had then to learn from experience that the production of gauges could not be rushed, but that an apparently simple gauge might easily take four or five days to produce. Looked at from the former standpoint such a gauge had the appearance of being worth a few shillings only, and it was by no means easy to appreciate the necessity of spending unlimited time on both master and working gauges.

An interesting fact which soon emerged was that even the most highly skilled men, while they could produce, say, half of every article required to the finest standard of accuracy, could not repeat the same job more than once or twice without an error—that is, without the help of gauges. On the other hand, a skilled man of average ability, given gauges, could produce corresponding articles within the necessary limits and with the required finish.

The average skilled worker is conscientious in respect of the material with which he works. He is reluctant to scrap a job just because it does not conform exactly to specification. On munitions this outlook proved very costly because many parts were made and had all the appearances of suitability, but on final examination had to be scrapped. Furthermore, the South African worker had previously been accustomed to work, almost without exception, to a general blueprint. That is to say, he took his detail from the print, obtained his vital measurements, and used his own judgment very largely for the rest. While this system proved very economical in jobbing engineering, it was unsuitable for the more exacting requirements of munitions production.

It has long been recognised by all manufacturing concerns that no tradesman, however skilled, can produce any article in quantity from a general drawing. He must have the part extracted from the drawing; in other words he needs a separate drawing showing the particular operation on which he is himself engaged. When it is remembered that many components involve anything up to 20 separate operations, it will be realised that for even a comparatively simple assembly 200 separate prints might be required.

War Supplies Board

Overseas, when any general engineering firm is given a contract for munitions, the firm is supplied with all information as to the methods found most suitable after extended experiments, and is also supplied with specimen operation drawings, jig, and working and inspection gauges. In South Africa such facilities were naturally out of the question, and for months it was a case of "cut and try." To-day there is a well-organised War Supplies Board which supplies the firms concerned with complete sets of detailed drawings. In the early days of defence production, however, existing ordinance drawings were modified to suit conditions in South Africa, bearing in mind the plant and materials available locally for manufacture in quantities. It was a commercial drawing-office, for example, which traced drawings of howitzer and trench mortars for the Defence Department, when the South African munitions industry was still in the embryo stage.

In order to produce accurate work, even with gauges, accurate machine tools are indispensable. Machine tools made by reputable firms leave the factory capable of producing work of almost any degree of accuracy. On the other hand, neglect on the part of the operator and management results in deterioration of the adjustment within a remarkably short space of time. Cutting compounds vary; some have a highly detrimental effect on the working parts of a machine, some are actually so heavy that they will float gritty particles to all the working parts. Before the outbreak of war, oil as a coolant was little used for machine tools in South Africa. It has now been found that for accurate work and to prolong the life of a machine tool and cutting tool, great attention must be paid to the cooling medium.

Yet another aspect of production which had not previously been developed in the Union to any great extent was tool-storage supervision and maintenance. In the majority of factories, very valuable tools and jigs were left lying around the shop indiscriminately. Deterioration was therefore extremely rapid, with consequential deterioration of the work. What had formerly seemed an unnecessary expense—namely a tool store and a well-equipped tool room with a highly paid tool-room man—soon proved a vital necessity.

Lubrication Problems

Specialised applications of high-tensile steels were not very widespread in South Africa before war broke out, and the mastery of these materials involved certain difficulties which only experience could overcome. It soon became apparent that very close attention to cutting lubricants was essential. When emulsified oils are used with high-tensile steels, due to a chemical reaction the scale in the billets and forgings tends in many cases to change the lubricant into a corrosive. The corrosive fluid works its way into the gear-boxes and feed-boxes of machines, and shortens their life very appreciably. Furthermore, in any wide cuts, such as in forming and scrape-finishing, emulsified oil tends to glaze the job, and in a very short period the tool rides and is then inclined to dig or tear. Hence the inferior finish of many of the industry's early products. Cutting oil, on the other hand, does not under any circumstances glaze, and while the polish—or apparent polish—after the cut is not quite so high, the accuracy remains to a far greater extent than when an emulsion is employed.

In considering these and other important problems which had to be solved before production could be organised on a fully efficient basis, the most essential point to remember is that delivery was a matter of extreme urgency. Given eighteen months or two years of costly experimental and educational work, it would have been possible to produce any type of defence requirements in South Africa with locally trained craftsmen—subject, of course, to the machine tools, equipment and materials being available. Owing to the urgency of the situation, however, it was a case of "Get on and do your best." Under the circumstances, it is remarkable testimony to the enthusiasm and determination of all concerned that, working under such formidable difficulties and at top pressure, the industry should have succeeded in manufacturing a wide range of military equipment of commendable quality. Not only are the products of local workshops proving of inestimable value to South African forces in the north, but in some cases they are actually being supplied to the Imperial troops.

Now that the industry has more or less cut its teeth on high-tensile materials and been spoonfed on microscopic measurements, it may confidently be anticipated that in quantity, quality and variety, the output of munitions will continue steadily to improve on the already satisfactory position.

* Reprinted from "Engineer and Foundryman" (South Africa) by courtesy of the Editor, the author of this article.

Sheet and Strip Bibliography

Research Bulletin No. 5, issued by the Sheffield City Libraries, is the third and final part of a Select Bibliography on the Production of Steel Sheets and Strip. It covers sheet and strip testing and inspection, and is divided into five parts:—Specifications; general books and periodical references; testing; ageing, grain growth and metallography; and boiler plate and other individual products. The three bulletins comprise a most useful bibliography of the subject and are available to our readers on writing to the Chief Librarian.

A Useful Diary

We have received from International Alloys, Limited, of Buckingham Avenue, Trading Estate, Slough, a particularly useful diary. It combines the functions of a pocket wallet, provision having been made for the accommodation of notes, a 4-day to the page diary, and a technical reference book. No fewer than 74 pages are devoted to the third section, and much of the data presented is of a unique and helpful character.

Cast-Iron Electrodes for Welding Grey Cast Iron

By GILBERT S. SCHALLER

(*Continued from page 158.*)

Test Procedure

A considerable amount of experimentation was used in developing proper procedures and techniques in the welding tests. This consisted of using varying settings on the welding generator that would yield satisfactory results in welding. The same precautions were followed for polarity settings. All welding was done with d.-c. machines where it was found that for the coatings under investigation reversed polarity delivered the best results. Accordingly, then, all test welding was done with reversed polarity and all results reported here must be interpreted from that condition.

The result of preliminary welding tests indicated that a current value of 200 amp. at 25 volts delivered the best results on electrodes of $\frac{3}{16}$ in. dia., that is, base size. On the $\frac{1}{8}$ in. base diameter electrode, the welding current was used at 125 amp. and 25 volts. These current values were basic through the experiments, although they were varied where different coatings indicated changed heat requirements. It is obvious that the number of combinations possible in tests could not all be investigated with any degree of thoroughness, consequently those values and conditions that indicated sound conclusions were the ones most frequently used.

Two Welding Methods Used

The welding technique as well as the varying heat values were investigated. Two different methods of welding were used. The difference resolved itself into the heat input in each case. In one group, a low heat input was used by obtaining fusion with rather shallow penetration by the molten metal from the arc contracting the parent metal. These welds were more in the order of the ones generally associated with the metallic arc-welding process, in that the heat was of a localised character rather than one spread through the work, thereby extending the temperature gradient.

The second technique was one similar to that used in torch welding, in which the idea of puddling the molten pool of metal predominates. These welds were made in a series of passes so that gases and slag inclusions were liberated or floated. It is not possible to draw definite conclusions as to the desirability of either of these procedures so far as industrial application is concerned, because the specimens used were considerably smaller in cross-section than the average casting of a machine part. However, indications are that the section shape and physical requirements of the part to be welded would, in the final analysis, be the governing factor.

All welding specimens were arranged on a copper backing strip in such a way that a $\frac{1}{8}$-in. root opening obtained. This opening was found necessary in order to gain full penetration—there not being sufficient metal thickness to make welding from both sides feasible. At best, with the $\frac{3}{16}$-in. electrodes, difficulty was encountered in getting the desired fusion at the root of the V separating the two weld pieces. The root opening also permitted of a degree of manipulation of the arc which made for uniformity of arc length and more even weld metal deposits.

Heat-Treatment

The matter of the machinability of the weld has already been mentioned, yet it seems that any discussion of grey cast iron invariably returns to that characteristic. One of the objectives of the tests was to investigate the desirability of preheating and post-heating. Instead of preheating in an orthodox manner by the use of some outside agency, the expedient of the use of the carbon arc was employed. Many test welds were made by adding a piece of carbon electrode about 1 in. in length on the end of the welding electrode. It was thought that the use of such a composite electrode would combine the metallic and carbon arc into an entity capable of performing all the requirements of a machinable weld.

The idea was partially satisfactory in that the carbon part of the electrode delivered an arc that handled the preheating aspect of the problem. However, it was found that in addition to this desirable feature, the difficult problem of carbon deposits on the surface of the parent metal was introduced, a situation which, from a practical standpoint, had the effect of cancelling any virtue that the carbon arc may have had from the standpoint of a preheating possibility. The idea of the composite electrode was not investigated fully. It does look inviting to preheat and weld without changing the set-up in any way.

After some investigation with the composite electrode, the remaining tests were made with specimens that had been preheated—that is, very few welds were completed with pieces at room temperature. The preheating was done in an oven-type furnace at temperatures of 150 deg. C. After welding, the test-pieces were allowed to cool normally to room temperatures without any decelerated cooling. The pieces remained on the welding table until they were cool enough to handle. Ordinary precautions were observed to prevent the pieces from being subjected to drafts that would induce rapid cooling or chilling.

Each series of weld specimens was subjected to a preliminary examination that consisted of a visual inspection of the weld deposit, fusion lines, penetration and heat effect. The specimens were then broken perpendicular to the weld line and a further visual inspection applied. In those cases where the weld was of such obviously poor quality as to be discarded, such action was taken without further examination. Those that indicated encouraging results were closely checked for effects of coating mixtures and heat values on the soundness, structure and fusion. From this group selected specimens were subjected to microscopic examination and study. It might be of interest to mention that more than a thousand test welds were made during the course of this investigation. In addition over one hundred coatings were compounded, some of which gave overlapping results and, in some cases, very poor results.

Classification of Coats

When the coating mixtures were being compounded, the guiding factor was that of producing a grey cast-iron weld metal, consequently the shielding materials show this trend most predominatingly. To be sure, the usual functions of shielded electrodes were not lost sight of. In fact, the coated electrodes used divide into three classes:—(1) Slag-forming coatings; (2) gas-shielding coatings; and (3) a combination of these two features.

The presence of the carbonates and the silicates of sodium and calcium supplied the necessary slag-forming ingredients. The resulting slag, of a lower specific gravity than the

TABLE I.—*Formulæ of Electrode Coatings.*

Test no.	Material used.	Per cent. (by weight).	Welding conditions.
1	Graphite ..	23.6	Reversed polarity, metal deposited in uneven globules. Fusion hindered by deposits of coating in walls of V.
	Sodium silicate..	66.9	
	Water	9.5	
4	Graphite ..	21.2	Arc sputtered at lower currents. Improved fusion and much more stable arc at 200 amp.
	Sodium silicate..	67.4	
	$Ca(OH)_2$ ..	2.9	
	Water	8.5	
5	Graphite ..	20.2	Fair fusion. Weld metal characterised by some gas inclusions.
	Sodium silicate..	64.3	
	$Ca(OH)_2$ ..	7.4	
	Water	8.1	
14	Graphite ..	17.3	First formula to yield a weld metal free of gas inclusions. Good fusion with narrow white line at fusion area. Dense, fine-grained metal harder than parent metal.
	Molybdenum ..	5.2	
	$CaCO_3$	5.2	
	Sodium silicate..	72.3	
15	Graphite ..	15.0	Weld deposit good. Poor penetration on fusion line.
	Sodium silicate..	77.5	
	Cellulose ..	3.75	
	Water	3.75	
19	Graphite ..	7.6	Surface preheated with carbon-arc composite rod. Poor fusion due to excessive carbon deposit on surface of V.
	Sodium silicate..	7.6	
	Cellulose ..	84.8	
23	Aluminium ..	4.4	Weld metal predominantly white iron. Poor fusion and penetration.
	Cellulose ..	4.4	
	Sodium silicate..	91.2	
49	Graphite ..	13.2	Uniform weld metal deposit.
	Cellulose ..	6.6	
	$CaCO_3$	2.7	
	Ferro silicon (75 per cent.) ..	4.0	
	Sodium silicate..	73.5	
50	Graphite ..	13.1	Weld metal and fusion line particularly free of gas. Very satisfactory fusion.
	Titanium oxide..	0.4	
	Cellulose ..	6.6	
	$CaCO_3$	2.7	
	Ferro silicon (75 per cent.) ..	4.0	
	Sodium silicate..	73.2	
65	Graphite ..	11.4	Poor fusion, blowholes in weld metal which tended toward whiteness. Fumes made welding uncomfortable for operator.
	$CaCO_3$	11.4	
	Ferro silicon (75 per cent.) ..	6.8	
	Lignin	70.4	
82	Graphite ..	11.2	Weld metal completely free of gas. Good fusion and penetration. Distinct but machinable line of fusion. Weld surface protected by heavy slag.
	$CaCO_3$	16.7	
	Ferro silicon ..	16.7	
	Sodium silicate..	46.5	
	Water	8.9	
96	Lampblack ..	12.2	Some included gas pockets on fusion line. Slightly more pronounced white iron than mixtures using graphite.
	$CaCO_3$	18.4	
	Ferro silicon (75 per cent.) ..	18.4	
	Sodium silicate..	51.0	
107	Graphite ..	15.2	Sound welds made with fairly uniform graphitic gradient. This shielding yielded uniformly satisfactory results.
	Na_2CO_3	15.2	
	Titanium ..	6.1	
	Sodium silicate..	63.5	
109	Graphite ..	15.7	Sound welds made at amperages in the 200 range. Welds machinable without post-heating.
	$CaCO_3$	23.5	
	Titanium ..	15.7	
	Sodium silicate..	32.6	
	Water ..	12.5	

weld metal, formed a protective coating or blanket on the weld metal deposit, shielding it from oxidation and other effects of the enveloping atmosphere. The gas shieldings were obtained in coatings containing cellulose, although carbon dioxide was developed through the reduction of carbonates. Experiments with these coatings indicated that the gas-forming feature, whilst of interest in minimising oxidation, showed itself as an important hindrance to sound weld metal because of the prevalence of blowholes in the latter. It was found that the size and number of gas inclusions in the weld metal could be controlled by adjusting the ingredients in the electrode coatings. The difficulty of gas inclusions proved a much greater problem than did the development of weld metal of acceptable metallurgical characteristics. This investigation has not developed to the point where positive statements can be made as to the gas-forming proclivities of certain ingredients or, more properly, combinations thereof. This condition will be noted by comparing the formulæ used and the results achieved by them.

Table I assembles a selection of the more interesting results found during the research.

Conclusions

These investigations, while somewhat extensive, are not at all exhaustive in that much more can be done in the direction of evaluating the effect of various welding heats and coatings on both the weld and the parent metal. The subject of shielding or coating formulæ is, indeed, one that lends itself to much additional experimentation, although results obtained in these studies indicate the path of future progress.

The tests made with low and high heat input (125 to 200 amps.) showed that at the lower heats the inclusion of gas in the weld metal was much more sensitive to the composition of the coating, whereas at the high heat, concentrated gases and slag were liberated with greater despatch, and fewer such inclusions resulted.

When heat input was used on the high side, a more distinct line of fusion resulted, as noted from a study of the resulting fractures. The microscopic studies, however, showed that free graphite is plentiful in this region, indicating that the carbon is not oxidised and the silicon not excessively volatilised due to prolonged or increasing heat.

In those tests where less heat was employed, the fusion line of the weld is narrower, yet the change in size and shape of the graphite plates is much more abrupt. This shows the quenching effect of the lower heat in that graphite formation is hindered due to the lesser time allowed for solidification and subsequent cooling.

A difficulty frequently encountered in the welding tests was that, when using $\frac{1}{4}$-in. electrodes on lower heat input, a carbon film formed on the surface of the V, which prevented smooth flow of the metal and hindered complete fusion because of its insulation effect. Too much of the carbonaceous matter in the coatings was liberated as mechanically free graphite which did not enter into solution with the molten metal of the welding operation. This condition was largely overcome at the higher amperage ranges, due, probably, to the fact that the molten pool was larger, thereby enabling the assimilation of the materials of the coating by the molten metal.

Welds made with cast-iron electrodes developed in this investigation were readily machinable with the usual type of high-speed steel tool bits. Machining was done on most of the specimens welded, since it was felt that such a test would be a definite indicator as to the type of material in the weld deposit. This was done by fracturing the welded specimen transverse to the weld and then machining the fractured surface in a shaper. Some machining tests were carried on until the major part of the specimen had been reduced to chips.

Another indication of the machinability can be had by noting the hardness test values. The following Rockwell hardness readings were taken from representative welded specimens:—

(1) Parent metal—B 79 to B 101, average B 89.
(2) Fusion zone—B 89 to B 100, average B 95.
(3) Weld metal—B 95 to B 109, average B 100.

The major results of this investigation show the possibility of developing coated cast-iron electrodes that will produce sound, machinable cast-iron weld metal. No attempt has been made to evaluate these results in the light of current industrial practice. This investigation was not intended as a comparison of materials and processes developed here as against any that are now used or have been employed in the welding of cast iron with the electric arc. It must also be remembered that so far as this investigation has proceeded, all work has been of a laboratory nature. Further work, when undertaken, will be directed toward the study of procedures necessary when heavier sections are welded, or when the parent metal has been subjected to service conditions which may have resulted in introducing situations which have affected the casting such as excessive heating, corrosion or the like.

Presentation of the E. J. Fox Medal

SUCCESSFUL GATHERING IN SHEFFIELD

Over 150 members and guests assembled at the Royal Victoria Hotel, Sheffield, last Saturday week to honour Mr. W. J. Dawson, who was recently awarded the E. J. Fox Medal by the Institute of British Foundrymen. Unfortunately, owing to illness, Mr. Dawson was unable to be present and the medal, which was handed over by Dr. J. E. Hurst, was received by his colleague, Dr. R. J. Sarjant. The function was presided over by Mr. Malcolm Brown, president of the Sheffield Branch of the Institute. The principal speakers were the Lord Mayor (Councillor L. F. Milner), Dr. W. H. Hatfield, F.R.S., Dr W. J. Rees, Dr. J. E. Hurst, Dr. R. J. Sarjant, Dr. P. Longmuir and Mr. J. W. Gardom. Mr. T. R. Walker, M.A., the honorary branch secretary, was responsible for the organisation of this entirely successful function.

(*Continued from next column.*)

A core such as this is reinforced with a number of "stiffeners." These are thin rings of cast iron which are made in a deep mould of the required internal and external diameter by pouring a sufficient quantity of iron to make one ring of the required thickness. This is covered with sand and allowed to solidify and another is cast, and so on until the mould is full. After striking the core with board X, Fig. 3, it is dried, and the job assembled in a pit. The foundation plate carrying the flange and core is levelled in position, and the middle lowered over it. A plain cope completes the job, which is secured against "lift" by means of a "cross," as sketched in Fig. 4, connected to the foundation plate by suitable slings (see Fig. 5). The cross being placed on the top with four weights and wedged in position securely holds the whole job together. Rings E and G are made in halves and secured by fishplates; this is to facilitate their removal from around the casting without destroying them.

Some Jobbing Foundry Experiences—XX

By "TRAMP"

In No. III of this series (see the JOURNAL for August 8 last, page 94) a method was described for making small- and medium-sized castings such as shown in Fig. 1 in green sand. When the size increases, however, loam moulding is to be preferred if facilities are available for handling and drying. Fig. 2 shows a section of the assembled mould, and Fig. 3 the necessary sweeping boards. A *résumé* of moulding operations is as follows: A strong foundation plate is set in position and sweep A, Fig. 3, is secured in place. Hard-wood pins B provide the means for determining the diameter. These are to be preferred to a solid board, which in use would absorb moisture and swell, thus detracting from the accuracy of the job. After correct setting the bottom flange is swept, a layer of ashes for venting being used as at C, Fig. 2. The sweep not only forms the flange, but also strikes a joint along line D in Figs. 2 and 3. The "finger," as it is termed, forming

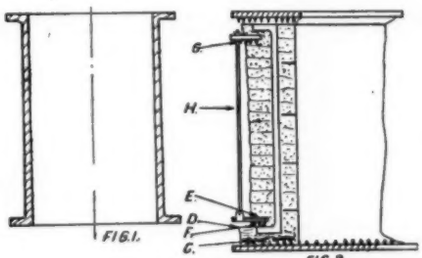


FIG. 1. FIG. 2.

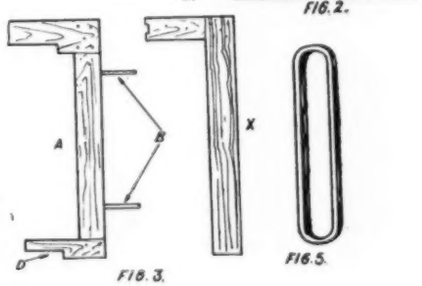


FIG. 3. FIG. 5.

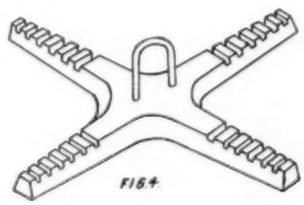


FIG. 4.

the bottom flange is removed from the sweeping board and the bottom allowed to stiffen.

The flange is dusted with parting sand and filled in with new red sand and the joint is made off level. After parting the top, a layer of loam is spread over it and a ring E with teeth F on the underside is bedded into the loam. On this plate, courses of brick are built to form the outside, and just before reaching the top another ring G is placed on the structure and bolted to the lower ring E by four or six bolts H. The mould is then struck off and lifted to the drying stove. The centre spindle is retained in position, together with the bottom plate carrying the flange. On to this is now built the centre core, which must be made so as to offer no resistance to the contracting metal. This is accomplished by using loam bricks in its building.

(*Continued in previous column.*)

The Week's News in Brief

Trade Talk

METAL INDUSTRIES, LIMITED, has decided to proceed with the acquisition of the ordinary and preference shares of Sentinel Waggon Works (1936), Limited.

THE BOARD OF TRADE have made an Order which comes into force at once prohibiting the export to any destination, except under licence, of mobile producer-gas units.

MATHER & PLATT, LIMITED, of Manchester, have introduced a system whereby the apprentices receive an hour each day for physical training and athletic pursuits. Experiments have shown that output is not materially affected by the shorter number of working hours.

UNDER THE TITLE of Stockton Construction Company, Limited, a new company has been registered "to carry on the business of shipbuilders, shipowners, etc." The nominal capital is £10,000 and the directors are Messrs. T. G. Wrightson, R. Miles, C. M. Spielman, J. R. Dixon and A. N. McQuistan.

THE LONDON OFFICES and showrooms of the following Radiation Companies are now centralised at 7, Stratford Place, London, W.1.: Arden Hill & Company, Limited; Davis Gas Stove Company, Limited; Eagle Range & Grate Company, Limited; Fletcher Russell & Company, Limited; Wilsons & Mathiesons, Limited; and John Wright & Company, Limited.

ANNOUNCING A NEW SALVAGE CAMPAIGN, the Controller of Salvage, Mr. Harold G. Judd, said on Monday that in addition to the 250,000 tons of metals obtained from ordinary collections, village dumps and the railings campaign had brought in thousands of tons. Over 100,000 tons had been sold by councils to industry. The possibilities of mobile crushers for country districts to flatten tins were being considered.

IT IS EXPECTED THAT BRITISH COKE will soon be used at United States blast furnaces in inland districts, owing to the growing scarcity of American coke. Some works near the coast are already importing metallurgical coke from the United Kingdom. Under present conditions it is stated British exporters can lay coke down at U.S. seaboard at a cost equal to American delivered prices. New coke capacity is being installed in America, and it is estimated that 3,000,000 tons of this new capacity will be in production by December next.

LAST JUNE THE U.S. RECONSTRUCTION FINANCE Corporation formed the Metals Reserve Company with a capital of $5,000,000 to acquire a reserve supply of critical and strategic materials. Up to the middle of January the commitments of the M.R.C. in the purchase of these supplies totalled nearly $377 million, and included orders for 200,000 tons of chrome ore, shared equally between the Union of South Africa and the Philippines, 2,058,040 tons of manganese ore (of which 1,335,000 tons is to be supplied by domestic sources), and 144,295 tons of tin ore (of which 90,000 tons is to come from Bolivia).

Personal

MR. J. GORDON MILLER, general works manager of Hardypick, Limited, Sheffield, who recently resigned from the chairmanship of the Institution of Factory Managers, has been elected a vice-president of the Institution.

MR. STANLEY BARNETT has been appointed by the Governing Council of the Constantine Technical College, Middlesbrough, to the post of lecturer in electrical engineering, in succession to Mr. John Pilling, who has been appointed head of the electrical engineering department at the Chesterfield Technical College.

Wills

LANG, C. R., engineer, of Holm Foundry, Cathcart, Glasgow £68,165

MACKENZIE, L. P., of Edinburgh, chairman of Mackenzie & Moncur, Limited, engineers and ironfounders £34,191

GJERS, JOHN, of Middlesbrough, managing director of Gjers, Mills & Company, Limited, pig-iron manufacturers £41,584

MACKENZIE, L. P., chairman of Mackenzie & Moncur, Limited, engineers and ironfounders, of Edinburgh £34,191

Obituary

MR. THOMAS AUSTIN DIPPY, of Cardiff, late of the administrative staff of the Mond Nickel Company, Limited, Clydach, Swansea, died last week.

MR. GEORGE BURNS WALLACE, formerly of John Wallace & Sons, Limited, agricultural engineers, Glasgow, died at Johannesburg on February 26.

MR. ESTCOURT GOODDINE POTTER TIMMINS, a director of the Runcorn engineering firm and foundry of E. Timmins & Sons, Limited, died recently, aged 40.

MR. WILLIAM THOMSON, director of the Shotts Iron Company, Limited, and chairman of the Leith shipowning firm of William Thomson & Company (Ben Line Steamers, Limited), founded by his grandfather, has died at his home at Edinburgh.

MR. THOS. THOMPSON, secretary and a director of Head, Wrightson & Company, Limited, of Thornaby and Stockton, who was also secretary and a director of the Stockton Steel Foundry Company, Limited, an associate company, died on Sunday last. A native of Northumberland, Mr. Thompson had been associated with the company for 48 years.

Contracts Open

Ashington, March 25—Iron castings for the 12 months commencing April 1, for the Urban District Council. The Surveyor, Council Offices, Ashington, Northumberland.

Brynmenyn, March 22—Iron castings during the 12 months ending March 31, 1942, for the Ogmore and Garw Urban District Council. Mr. Albert H. Jenkins, engineer and surveyor, Council Offices, Brynmenyn, Glam.

Grenoside, March 19—Iron castings during the year ending March 31, 1942, for the Wortley Rural District Council. Mr. J. Gregory, engineer and surveyor, Council Offices, Grenoside, Sheffield.

Company Meeting

Clarke, Chapman & Company, Limited

Their financial position was stronger and sounder than it had ever been in their history, said MR. W. A. WOODESON at the annual meeting of Clarke, Chapman & Company, Limited, held at Gateshead on February 28. They had been extremely busy and had carried out and completed large orders, some of them of a very special nature, but all of them more or less associated with the class of work they had been accustomed to. All departments had had a good share of the orders. The electrical, the steam and general, the water-tube boiler and the various miscellaneous departments had all contributed well towards the yearly results.

New Companies

(From the Register compiled by Jordan & Sons, Limited, Company Registration Agents, 116 to 118, Chancery Lane, London, W.C.2.)

South Wales Metal Refiners (1941), Limited—Capital, £20,000. Subscriber: G. F. Austin, 18, Austin Friars, London, E.C.2.

Plews & Turner, Limited, Bridgefield Ironworks, Elland, Yorks—Capital, £3,000. Engineers and ironfounders. Director: H. W. Plews.

Edmar Printing Metals, Limited, Edmar Works, Mill Green Road, Mitcham, Surrey—Capital, £7,500. Directors: E. J. and M. A. Harrison.

Abrasive Manufacturing Company (Lancs), Limited, Grove Mill, Padiham, Lancs—Capital, £1,260. Directors: J. P. and K. F. Rosenberg.

Kenyon Casting Company, Limited, 126, Northwood Street, Birmingham—Capital, £250. Casters of non-ferrous metal alloys, etc. Directors: A. H. Doley and C. H. Bond.

Evans Bailey, Limited, Church Street, Shipston-on-Stour—Capital, £1,000. Engineers, founders, etc. Directors: R. E. R. Evans, F. Bailey, E. G. Kesler, A. Lorimer, and W. H. Long.

Stockdale Laurie & Company, Limited—Capital, £1,000. Manufacturers and founders of aluminium and other metals, etc. Directors: W. B. Stockdale Laurie, Cippenham Lodge, Slough, Bucks; E. M. S. Napier and J. A. Leonard.

Reports and Dividends

Crabtree Electrical Industries, Limited—Interim dividend of 5 per cent.

Blythe Colour Works, Limited—Dividend on the 6 per cent. preference shares.

Qualcast, Limited—Interim dividend on the ordinary shares of 10 per cent. (same).

Coltness Iron Company, Limited—Final dividend dividend of 15 per cent. on the ordinary shares, again making 20 per cent. for the year.

Midland Electric Manufacturing Company, Limited—Dividend on the ordinary shares for 1940 of 10 per cent., together with a cash bonus of 15 per cent.

Hammond Lane Foundry Company, Limited—Net profit for 1940, £12,006 (against £13,470); final dividend of 7 per cent., making 10 per cent. (12½ per cent.); carried forward, £2,123 (£1,974).

Lanarkshire Steel Company, Limited—Dividend of 12½ per cent. (same); taxes, £106,626 (£81,834); depreciation, £25,000 (same); to reserve, £20,000 (same); carried forward, £87,439 (£100,592).

Thomas Robinson & Son, Limited—Profit for 1940, £30,828; brought in, £24,541; dividend on the preference shares, £11,250; dividend on the ordinary shares of 5 per cent. for the year, £11,079; carried forward, £33,040. Meeting, March 19.

Cammell Laird & Company, Limited—Net profit for 1940, after charging depreciation, debenture service and taxation, £241,852 (£225,394 for 1939); to reserve, £100,000; brought in, £65,023; dividend of 10 per cent. (same); carried forward, £104,812. Meeting, April 1.

Beans Industries, Limited—Net profit for the year to September 30 last, after taxation and depreciation, £53,432 (against £63,911 for 1938-39); dividend on the ordinary shares of 37½ per cent. (same); to employees' pension fund, £2,500; to general reserve, £25,000; carried forward, £20,237 (against £19,531 brought in).

Patent Specifications Accepted

The following list of Patent Specifications accepted has been taken from the "Official Journal (Patents)." Printed copies of the full Specifications are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2, price 1s. each. The numbers given are those under which the Specifications will be printed and abridged, and all subsequent proceedings will be taken.

525,706 ELECTRO METALLURGICAL COMPANY. Treating molten iron or steel, and addition agents therefor.

525,822 HOLLAND & HANNEN & CUBITTS, LIMITED, and HATCHARD, M. GALLAI-. Foaming or granulating blast-furnace slag or other suitable molten material.

525,971 NATIONAL CYLINDER GAS COMPANY. Apparatus for the hardening of metal surfaces.

526,443 LONGDEN, E. Cupola furnaces.

526,746 JONES, W. L. (Electric Furnace Company). Radiant-heat tube furnaces.

526,805 FRANCIS, E. L. (Illinois Testing Laboratories, Inc.). Devices for detecting magnetic metal.

Forthcoming Event

Institute of British Foundrymen

MARCH 15.

East Anglian Section:—Annual general meeting. "Precautions to be Taken in the Production of Sound Malleable Iron Castings," Paper by V. N. Wood, in Ipswich, at 3.30 p.m.

STEEL GRIT ROUND & ANGULAR
FOR SHOT BLASTING.
Prompt Deliveries at Controlled Prices.
MOWAT'S PIONEER GRIT CO. LIMITED.
HOLLAND STREET, ABERDEEN

% SAVING

BY PATCHING CUPOLAS

with GLENDOLINE

- **Highly Refractory.**
- **Easily applied.**
- **Consistent in quality.**

GLENDOLINE is a plastic refractory considered by many users to be the ideal cupola patching material. Modern methods of manufacture, including strict control of mixing and grading, ensure a consistently uniform product of high dependability.

Some founders who use Glendoline report that savings in the quantity of refractories consumed per ton of iron melted approximate to 25%.

Further information will be sent on request.

GENERAL REFRACTORIES LTD.

HEAD OFFICE: GENEFAX HOUSE, SHEFFIELD, 10. TELEPHONE 31113 (6 LINES)

G.P.11.

FIREBRICKS: *Glenboig Special, Glenboig Special Crown, Glenboig, Glenboig Crown, Castlecary, Dykehead, Gem, White Carr, Stour, Hycone, Alumantine, Hysilyn, Adamantine, Llangennech.*
BASIC BRICKS: *Spinella, Saxpyre, Supermag, Diazite, Dolomax.*
ACID-PROOF REFRACTORIES: *Obsidianite, Losol,*

INSULATION: *Amberlite* Bricks, Cement and Concrete. SILICA BRICKS: *Lowood, Meltham, Allen, Quartex.* CEMENTS: *Sintex, Durax, Pyrolyte.* PLASTICS: *Durax, Rotaline, Plastic K-N., Glendoline, Ground Ganister.* SILLIMANITE: Tank Blocks, Bricks and Cements. SANDS: Moulding, Brick Facing, Silica, Glass

Raw Material Markets

Iron and steel makers continue to make every effort to satisfy the ever-increasing demands of consumers engaged on war contracts, and are disposing readily of their full outputs under licences granted by the Control. Priority users are taking up the bulk of productions, and the parcels made available for ordinary domestic consumers tend to decrease in volume, while exports are on a comparatively small scale and are largely for buyers in the Dominions and Colonies employed on projects connected with that war effort. As the end of the first quarter of the year approaches it is evident that many iron and steel makers will have to carry over into the following quarter commitments which should have been dealt with in Period 1. This does not indicate any falling away of output, however, as licences always cover a heavier tonnage than can be attained, and the deficiency in cases of high-priority consumers is usually made up from material imported by the Control.

Pig-Iron

MIDDLESBROUGH—High-phosphorus iron for the light foundry trade is easily procured, although it is necessary first to obtain a purchase licence from the Control. Taking the trade as a whole, there is room for considerable improvement, which, it would appear, can only be brought about by the acquisition of Government orders on a much larger scale than has yet been the case, as many of the ordinary outlets for light castings have been adversely affected by the war. The building trade is calling for castings on an increasing basis, but it is unlikely that manufacturers will attain a really satisfactory level of production unless they are able to adapt their plant to cope with the requirements of Government departments. Iron for these users is being supplied by Midland producers, as output of Cleveland iron remains negligible.

Owing to the very heavy demand for hematite and the necessity for importing supplies on a quite considerable scale, distribution is carefully regulated and is, in fact, confined to priority consumers. Other grades of iron are being utilised where substitution is possible, and this relieves to some extent the pressure on hematite. Rather larger supplies have been available for distribution during the past week or two, and the position is expected further to improve, although no material change in the situation is anticipated in the near future, as home output cannot easily be increased.

LANCASHIRE—The demand for foundry pig-iron from makers of light castings is not very large, and reflects the condition of producers' order-books, which have been severely reduced by the war. Some jobbing founders, too, are in need of additional employment, but, on the whole, this industry is fairly well situated. Pig-iron is being taken up in large tonnages by the heavy engineers, who are mostly operating to capacity on Government orders; deliveries of Derbyshire and Staffordshire brands are satisfactory. Hematite is not coming through as freely as is desired, but a certain amount of refined iron is being used to make up the deficiency.

MIDLANDS—Consumption of high-phosphorus iron tends to expand, as, in addition to a good demand from the light-castings makers, the chief users of this type of iron, more is going into the mixtures of the heavy engineers. Light-castings makers, generally, have better order-books than for some time past, and many of these works are sharing in official contracts, although not to the extent which, it is hoped, will be the case later, while demands from ordinary domestic users tend to increase, especially from the building trade. Machine-tool makers and other heavy engineering concerns continue to be fully employed and are booked up well ahead. Supplies of low-phosphorus iron and hematite for these concerns cannot be met in full by home production, and substantial quantities are being bought overseas. Refined irons are in good supply, and these are being incorporated in mixtures where possible.

SCOTLAND—Demand for Scotch foundry iron is maintained at a high level and, unfortunately, deliveries are behind schedule in some cases. Heavy engineers have as much work on hand as they can tackle over some months to come, with the prospect of replacement orders being handed out as and when required. Although there is no iron to spare, urgent needs are being met promptly. Moderate activity is reported by the light-castings section, their position having recently been improved by the placing of orders for stoves for air-raid shelters. As it is no longer possible for these establishments to draw their iron from the Cleveland district, supplies are now purchased in the Midlands, furnaces there being able to deliver adequate tonnages.

Coke

Distribution of foundry coke continues to be satisfactory, and fewer delays are experienced week by week; in any case, most consumers have considerable stocks on hand, and are adding to these steadily. Producers are willing to book ahead despite the uncertainty of the future price position, the price paid for coke being that current at the time of delivery. The present figure is 61s. 6d. per ton, delivered Birmingham and Black Country stations in truckloads.

Steel

Home production of steel, supplemented by shipments of foreign material, is able to look after the more urgent demands on the industry. The present system whereby all business in steel is conducted through the Control authorities ensures a satisfactory flow of deliveries to consumers dealing with orders for the Government, but in the circumstances the needs of the ordinary domestic user have to be passed over to a large extent. If more attention were to be paid to the latter additional imports would have to be arranged, and these are being restricted to really urgent requirements for obvious reasons. Deliveries from home works have improved following delay due to inclement weather. Most sections of the steel trade are inundated with work, and pressure tends to become even more insistent, particularly for special grades for the production of shells and other munitions and for steel suitable for the ship building and repairing yards. Deliveries of these qualities are at a high level.

Scrap

Demand for steelworks' scrap is a feature of the scrap iron and steel trade, and orders tend to be ahead of available supplies. Rail transport has improved, and has resulted in a slightly better flow of deliveries, but the shortage of suitable labour in some areas is a problem. However, the basic cause of the inadequate supply of scrap is that the necessary measures have not been taken in certain districts for the collection of the metal, and until this is rectified the situation can hardly be expected to improve unless additional imports are negotiated. The purchase of more foreign scrap than is absolutely essential would be folly, of course, at a time when shipping space and foreign exchange are of the utmost value. Demolition scrap is slow to come forward, and an early start might well be made in the collection, classification and distribution of much more of this material than has so far been delivered to consuming points.

Metals

Copper—Owing to the veil of secrecy surrounding Government contracts in wartime, it is not possible to divulge the tonnage of copper being absorbed in official work. It is certain, however, that consumption will be even heavier this year than was the case in 1940, in view of the Government's statements on the future trend of war production. So far the Control have been able to satisfy priority demands for copper with little, or no, difficulty, but ordinary domestic users are being rationed very stringently.

Tin—Firm conditions have continued in the tin market, but the tone has been rather steadier than it had been during the past few weeks. Prices have been well maintained, despite the many rumours in circulation regarding the possibility of the Government's reimposing a maximum price for the metal. A meeting of the International Tin Committee is due to be held this month, when it is presumed that the question of the renewal, or otherwise, of the restriction scheme will come up for consideration. The opinion is gaining support that the discussions may be rather more lengthy than was earlier anticipated.

Further details have come to hand regarding the proposed American tin smelter. It is announced that the Billiton concern is to start immediately on its erection at Texas City. The company will receive a fee of 4 per cent. of the cost of construction, and an operating fee of rather less than 1 per cent. of the value of the finished tin.

The Statistical Bulletin of the Tin Research Institute estimates world production of tin in January at 17,500 tons, compared with 15,100 tons in January, 1940. United States deliveries totalled 12,760 tons in January, against 9,780 tons in the same month of last year. Deliveries for the twelve months ended January 31 were 118,477 tons, against 77,346 tons in the previous twelve months. Tin consumption in the United Kingdom amounted to 29,225 tons in 1940, against 27,279 tons in 1939, and 18,290 tons in 1938. World stocks of tin, including smelters' stocks and carry-over, decreased by 1,176 tons during January to 59,806 tons at the end of the month. Stocks at the end of January, 1940, were 49,370 tons.

Tin prices on the London Metal Exchange during the past week have been as follow:—

Cash—Thursday, £266 to £266 10s.; Friday, £267 to £267 5s.; Monday, £269 to £269 5s.; Tuesday, £268 5s. to £268 10s.; Wednesday, £269 to £269 5s.

Three Months—Thursday, £266 to £266 5s.; Friday, £266 5s. to £266 10s.; Monday, £268 5s. to £268 10s.; Tuesday, £267 to £267 5s.; Wednesday, £266 10s. to £266 15s.

Spelter—Large supplies of zinc are passing into consumption among works engaged on Government contracts, leaving comparatively small tonnages available for distribution among non-essential users.

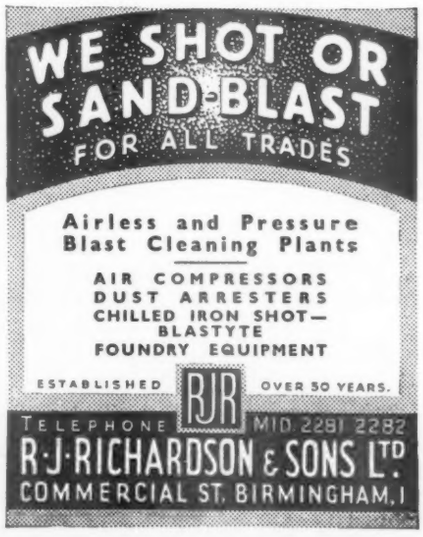
Lead—The lead situation remains eminently satisfactory, with supplies plentiful to meet all demands. Consumption on Government account may be expected to increase, but reasonable tonnages should remain on hand to satisfy other requirements.

EMPLOYMENT REGISTER.

Correspondence should be addressed to the General Secretary, Institute of British Foundrymen, St. John Street Chambers, Deansgate, Manchester, from whom full particulars can be obtained of this service.

MANAGER for Foundry Trade. Over 30 years' experience light general and electrical castings. Foundry, patternshop, drawing office, machine shop, sales experience. (402)

FOUNDRY Foreman, aged 48, 26 years in control of grey-iron casting production. Machine and hand moulders, repetition and general, also non-ferrous castings. (404)



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—to-day and to-morrow

In the unceasing development of Aluminium Alloys you can be sure that from our wealth of scientific experience, every help the foundryman can be given in perfecting casting technique, is given by International Alloys Ltd. Whenever there is a new specification for an Aluminium Alloy you can always rely upon this organisation as your best source of supply.

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RAW MATERIALS—PRICE LIST

Wednesday, March 12, 1941

COPPER*

	£	s.	d.
Electrolytic	62	0	0
High-grade fire-refined	61	10	0
Fire-refined of not less than 99.7 per cent.	61	0	0
Do., do., 99.2 per cent.	60	10	0
Black hot-rolled wire rods	65	10	0

TIN

	£	s.	d.
Standard cash	269	0	0
Three months	266	10	0
Settlement	269	5	0
Official average Cash, Feb.	265	3	10½
Do. Three Months, Feb.	263	19	7½
Do. Settlement, Feb.	265	2	9

SPELTER*

	£	s.	d.
G.O.B. (foreign) (duty paid)	25	15	0
Do. (domestic)	26	10	0
"Prime Western"	26	10	0
Refined and electrolytic	27	5	0
Not less than 99.99 per cent.	28	15	0

LEAD*

	£	s.	d.
Good soft pig lead (foreign) (duty paid)	25	0	0
Do., do., (Empire and domestic)	25	0	0
English	26	10	0
Sheets, home	34	10	0
Do. export, f.o.b.	31	0	0
Pipes, home	34	0	0
Do. export, f.o.b.	31	10	0
Tea lead (nom.)	—		

ALUMINIUM

Ingots	£110
Wire, 10g.	nom.
Sheets	nom.
Circles, 20/24g.	nom.

ZINC SHEETS, etc.

	£	s.	d.
Sheets, 10g. and thicker, ex works	39	2	6
Rolled zinc (boiler plates), ex works	37	2	6
Zinc oxide (Red Seal), d/d buyers' premises	28	7	6

ANTIMONY

	£	s.	d.
English, 99%, delivered	85	0	0
Foreign Regulus, duty paid	88 0 0 to 91	0	0
Chinese, prompt shipment, c.i.f.	76 0 0 to 80	0	0

QUICKSILVER

Quicksilver, ex-w'hse London 49 0 0

HIGH-SPEED TOOL STEEL

Finished bars, 14% tungsten 3s. 0d.
Finished bars, 18% tungsten 3s. 10d.
Finished bars, 22% tungsten 4s. 4d.
Per lb. d/d buyers' works.

NICKEL SILVER, etc.

	Per lb.
Ingots for raising	10d. to 1/4
Rolled—	
To 9 in. wide	1/4 to 1/10
To 12 in. wide	1/4½ to 1/10½
To 15 in. wide	1/4½ to 1/10½
To 18 in. wide	1/5 to 1/11
To 21 in. wide	1/5½ to 1/11½
To 25 in. wide	1/6 to 2/–
Ingots for spoons and forks	10d. to 1/6½
Ingots rolled to spoon size	1/1 to 1/9½
Wire round—	
to 10g.	1/7½ to 2/2½

with extras according to gauge.

Special 5ths quality turning rods in straight lengths, 1/6½ upwards.

* Maximum prices per long ton delivered to buyers' premises.

FERRO-ALLOYS AND STEEL-MAKING METALS

	£	s.	d.
Ferro-silicon (5-ton lots)—			
25%	21	0	0
45%	23	10	0
75%	36	10	0
Ferro-vanadium—			
35/50%	1/3 lb. Va.		
Ferro-molybdenum—			
70/75% carbon-free	6/– lb. Mo.		
Ferro-titanium—			
20/25% carbon-free	1/9 lb.		
Ferro-tungsten—			
80/85%	5/1 lb.		
Tungsten metal powder—			
98/99%	5/2½ lb.		
Ferro-chrome—			
2/4% car.	—		
4/6% car.	47	0	0
6/8% car.	47	0	0
8/10% car.	—		
Ferro-chrome—			
Max. 2% car.	1/0¾ lb.		
Max. 1% car.	1/1½ lb.		
Max. 0.5% car.	1/1¾ lb.		
70% carbon-free	—		
Nickel—99.5/100%	£190 to £195		
"F" nickel shot	175	0	0
Ferro-cobalt, 98/99%	8/9 lb.		
Metallic chromium—			
96/98%	3/9 lb.		
Ferro-manganese—			
76/80% loose	18	10	0
76/80% packed	20	0	0
Metallic manganese—			
94/96% carbon-free	1/9 lb.		

Per ton unless otherwise stated, basis 2-ton lots, d/d Sheffield works.

SCRAP*

	£	s.	d.	£	s.	d.
SOUTH WALES—						
Short heavy steel, not ex. 24-in. lengths	4	2	0	to 4	4	6
Heavy machinery cast iron				4	7	0
Ordinary heavy cast iron				4	2	0
Cast-iron railway chairs				4	7	0
Medium cast iron				3	18	3
Light cast iron				3	13	6
MIDDLESBROUGH—						
Short heavy steel	3	19	9	to 4	2	3
Heavy machinery cast iron				4	11	9
Ordinary heavy cast iron				4	9	3
Cast-iron railway chairs				4	9	3
Medium cast iron				3	19	6
Light cast iron				3	14	6
BIRMINGHAM DISTRICT—						
Short heavy steel	3	14	9	to 3	17	3
Heavy machinery cast iron				4	12	3
Ordinary heavy cast iron				4	7	6
Cast-iron railway chairs				4	7	6
Medium cast iron				4	0	3
Light cast iron				3	15	3
SCOTLAND—						
Short heavy steel	3	19	6	to 4	2	0
Heavy machinery cast iron				4	14	3
Ordinary heavy cast iron				4	9	3
Cast-iron railway chairs				4	14	3
Medium cast iron				3	17	3
Light cast iron				3	12	3

* Delivered free to consumers' works in England and Wales. For deliveries of cast-iron scrap free to consumers' works in Scotland, the above prices less 3s. per ton, but plus actual cost of transport or 6s. per ton, whichever is the less. All prices: Plus 2½ per cent. dealers' remuneration: 50 tons and upwards over three months 9d. extra.

PIG-IRON*

	£	s.	d.
N.E. COAST (d/d Tees-side area)—			
Foundry No. 1	131/–		
,, No. 3	128/–		
,, No. 4	127/–		
Forge No. 4	127/–		
Hematite No. 1	138/6		
Hematite M/Nos.	138/–		
N.W. COAST—			
Hem. M/Nos. d/d Glasgow	138/6		
,, d/d Birmingham	150/–		
MIDLANDS (d/d Birmingham dist.)—			
Staffs No. 4 forge	129/–		
,, No. 3 fdry.	130/–		
Northants forge	126/6		
,, fdry. No. 3	127/6		
,, fdry. No. 1	130/6		
Derbyshire forge	129/–		
,, fdry. No. 3	130/–		
,, fdry. No. 1	133/–		
Phosphorus 0.5% to 0.75%	137/6		
Phosphorus 0.1% to 0.5%	140/6		
SCOTLAND—			
Foundry No. 1, Grangemouth	127/3		
,, No. 3, Grangemouth	124/9		
Cleveland No. 3, Glasgow	131/–		
,, ,, Falkirk	128/–		
Scottish hem. M/Nos. d/d	138/6		
SHEFFIELD (d/d district)—			
Derby forge	126/6		
,, fdry. No. 3	127/6		
Lincs forge	126/6		
,, fdry. No. 3	127/6		
W.C. hematite	144/–		
LANCASHIRE (d/d eq. Man.)—			
Derby fdry. No. 3	133/–		
Staffs fdry. No. 3	133/–		
Northants fdry. No. 3	131/6		
Cleveland fdry. No. 3	133/–		
Cylinder and Refined Irons			
North Zone	174/–		
South Zone	176/6		
Refined Malleable			
Birmingham and S. Staffs	171/6		
Cold Blast			
South Staffs	220/6		

* Prices of hematite and basic pig-iron, and of foundry and forge iron with a phosphoric content of not less than 0.75 per cent., are subject to a rebate of 5s. per ton under certain conditions.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms and Slabs.

	£	s.	d.
BASIC:			
Soft, u.t., 100-ton lots	12	5	0
Tested, up to 0.25% C.	12	10	0
Tested, 0.25 to 0.33% C.	12	12	6
Tested, 0.33 to 0.41% C.	12	15	0
Hard (0.42 to 0.60% C.)	13	17	6
,, (0.61 to 0.85% C.)	14	7	6
,, (0.86 to 0.99% C.)	14	17	6
,, (1% C. and up)	15	7	6
Silico-manganese	16	5	0
Free-cutting	14	10	0
SIEMENS MARTIN ACID			
Up to 0.25% C.	15	15	0
Case-hardening	16	12	6
Silico-manganese	16	5	0

Billets, Blooms and Slabs for Forging and Stamping.

Basic soft, up to 0.25% C.	13	17	6
Basic hard, 0.41 to 0.60% C.	14	10	0
Acid, up to 0.25% C.	16	5	0

Other Semi-products, etc.

Tin bars	12	2	6
Sheet bars	12	2	6
*Wire rods, soft basic	17	7	6
,, hard basic	21	2	6
,, free-cutting	20	2	6
,, acid	24	13	6

* Subject to rebate.

FINISHED STEEL

Usual district deliveries.

[A rebate of 15/- per ton for steel bars, sections plates, joists and hoops is obtainable in the home trade under certain conditions.]

	£	s.	d.
Plates, ship (N.E. Coast)	16	3	0
Boiler plts. (N.E. Coast)	17	0	6
Chequer plts. (N.E. Coast)	17	13	0
Angles, over 4 in. ins.	15	8	0
Tees, over 4 in. ins.	16	8	0
Joists, 3 in. × 3 in. and up	15	8	0
Rounds and squares, 3 in. to 5½ in.	16	8	0
Rounds under 3 in. to ⅜ in. (untested)	17	12	0
Flats—over 5 in. wide	15	13	0
,, 5 in. wide and under	17	12	0
Rails, heavy, f.o.t.	14	10	6
Hoops	18	7	0
Black sheets, 24 g. (4 t. lots)	22	15	0
Galv. cor. shts. (,,)	26	2	6
Galv. flat shts. (,,)	26	12	6
Galv. fencing wire, 8g. plain	26	17	6

FINISHED IRON

	£	s.	d
CROWN IRON:			
England and Wales	15	12	6
Scotland	15	12	6
Ireland, f.o.q.	16	5	0
No. 3 BARS:			
England and Wales	12	10	0
Scotland	13	12	6
Ireland, f.o.q.	13	2	6
No. 4 BARS:			
England and Wales	13	0	0
Scotland	13	17	6
Ireland, f.o.q.	13	12	6
STRIP:			
England and Wales	17	0	0
STAFFS MARKED BARS, f.o.t.	18	10	0

AMERICAN IRON AND STEEL

At Pittsburgh unless otherwise stated, February 11, 1941

	Dols.
No. 2 foundry, Phila.	25.84
No. 2 foundry, Valley	24.00
No. 2 foundry, Birm.	19.38
Basic, Valley	23.50
Malleable, Valley	24.00
Grey forge, Valley	23.50
Ferro-mang., seaboard	120.00
O.-h. rails, h'y, at mill	40.00
Billets	34.00
Sheet bars	34.00
	Cents
Iron bars, Chicago	2.25
Steel bars	2.15
Tank plates	2.10
Beams, etc.	2.10
Wire rods	2.00
Skelp, grooved steel	1.90
Steel strip	2.10
Steel sheets	2.10
Sheets, galv., 24 g.	3.50
Wire nails	2.55
Plain wire	2.60
Tinplates, 100-lb. box	$5.00

COKE (at ovens)

(nominal)

Welsh foundry	47/6 to 49/–
,, furnace	35/6 to 37/–
Durham foundry	45/6
,, furnace	35/6
Scottish foundry	46/– to 51/–
,, furnace	35/6

TINPLATES

(f.o.b Bristol Channel ports)

I.C. cokes 20 × 14 per box	30/9 to 31/9
,, 28 × 20 ,,	61/6 to 63/6
,, 20 × 10 ,,	44/3 to 44/9
,, 18¾ × 14 ,,	32/– to 32/6
C.W. 20 × 14 ,,	27/9 to 28/9
,, 28 × 20 ,,	55/6 to 57/6
,, 20 × 10 ,,	42/3 to 42/9
,, 18¾ × 14 ,,	30/– to 30/6

NON-FERROUS SCRAP

(Official Maximum Prices, per ton ex Works.)

	£	s.	d.
Bright untinned copper wire, in crucible form or in hanks	57	10	0
No. 1 copper wire	57	0	0
No. 2 copper wire	55	10	0
Copper firebox plates, cut up	57	10	0
Clear untinned copper, cut up	56	10	0
Braziery copper	53	10	0
Q.F. process and shell-case brass, 70/30 quality, free from primers	49	0	0
Clean fired 303 S.A. cartridge cases	47	0	0
70/30 turnings, clean and baled	43	0	0
Brass swarf, clean, free from iron and commercially dry	34	10	0
New brass rod ends, 60/40 quality	38	10	0
Hot stampings and fuse metal, 60/40 quality	38	10	0
Admiralty gunmetal, 88-10-2, containing not more than ½ per cent. lead or 3 per cent. zinc, or less than 9½ per cent. tin	72	0	0

NEW BRASS TUBES, etc.

	Per lb.
Solid drawn tubes	13½d.
Brazed tubes	15½d.
Rods, drawn	11½d.
Rods, extd. or rlld.	8½d.
Sheets to 10 w.g.	10½d.
Wire	10½d.
Rolled metal	10d.
Yellow metal rods	8½d.

COPPER TUBES, etc.

Solid drawn tubes	15d.
Brazed tubes	15d.
Wire	9½d.

PHOSPHOR BRONZE

	Per lb. basis
Strip	13½d.
Sheet to 10 w.g.	14½d.
Wire	15½d.
Rods	15½d.
Tubes	21d.
Castings	17d.

Delivery 3 cwt. free.
10% phos. cop. £35 above B.S.
15% phos. cop. £40 above B.S.
Phosphor tin (5%) £40 above price of English ingots.
C. Clifford & Son, Limited.

AVERAGE MONTHLY PRICES OF STEEL RAILS

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.	£ s. d.
1926	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 0 0	8 7 6	8 10 0	8 10 0	8 10 0	8 10 0	8 3 11
1927	8 10 0	8 10 0	8 10 0	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 2 6	8 3 0	8 5 0	8 5 0	8 4 10
1928	8 5 0	8 5 0	8 5 0	8 5 9	8 6 3	8 6 3	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 7 9½
1929	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1930	8 0 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0	8 10 0
1931	8 9 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1932	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1933	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1934	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1935	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1936	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6	8 7 6
1937	8 7 6	8 7 6	8 7 6	8 7 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	9 10 10
1938	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6	10 2 6
1939	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 10 0	9 3 0	9 3 0	10 3 0	10 3 0	9 11 0
1940	10 3 0	11 3 0	11 3 0	11 3 0	11 3 0	11 3 0	12 15 6	12 15 6	12 15 6	12 15 6	14 10 6	14 10 6	12 3 5
1941	14 10 6	14 10 6	—	—	—	—	—	—	—	—	—	—	—

AVERAGE MONTHLY PRICES OF EAST COAST HEMATITE MIXED NUMBERS AT MIDDLESBROUGH*

Year	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.	s. d.
1926	77 3	77 9	77 3½	76 3	77 4½	78 0	79 8½	81 9	83 4½	87 7½	92 6	90 8½	81 7½
1927	90 0	90 0	86 3½	83 1½	80 6	78 0	76 6	75 4½	75 0	72 9	71 9	71 1½	79 2½
1928	69 7½	69 9	69 9	70 0	70 0	69 3	68 7½	69 2	70 0	70 0	70 3	71 0	69 9½
1929	71 6	72 0	73 6	74 0	74 0	74 1½	74 9	75 6	76 1½	76 8½	78 1½	79 0	74 1½
1930	78 2½	78 0	76 9	75 0	74 0	72 7½	71 0	71 0	71 0	71 0	70 10½	70 4½	73 3½
1931	70 0	69 0	68 0	66 8½	65 1½	63 4½	62 9	61 1½	65 0	65 0	65 0	65 0	65 6
1932	64 10	64 3	63 6	63 6	63 6	62 7½	62 0	60 6	60 0	59 3	59 0	59 0	61 10
1933	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 0	59 3	60 7½	62 6	62 6	59 8½
1934	62 6	65 0	67 6	67 6	67 6	67 6	67 6	67 6	68 0	68 6	68 6	68 6	67 2
1935	68 6	68 6	68 6	68 6	68 6	68 6	69 7½	70 6	70 6	70 6	70 6	70 6	69 5½
1936	70 6	75 3	76 6	76 6	77 4	80 0	85 0	85 0	85 0	85 0	85 0	85 0	80 6
1937	97 6	97 6	97 6	97 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	122 6	114 2
1938	132 6	132 6	132 6	132 6	132 6	132 6	132 6	132 6	132 6	132 6	132 6	132 6	132 6
1939	120 0	120 0	120 0	120 0	120 0	120 0	115 0	115 0	115 0	115 0	124 0	124 0	119 0
1940	124 0	127 0	127 0	127 0	127 0	127 0	130 6	130 6	130 6	130 6	138 0	138 0	129 9
1941	138 0	138 0	—	—	—	—	—	—	—	—	—	—	—

* Since March, 1934, delivered works; previously f.o.t. furnaces. Note.—Prices of hematite have since July 1, 1936, been subject to a rebate of 5s. under certain conditions.

WILLIAM JACKS & COMPANY
LIMITED
WINCHESTER HOUSE, OLD BROAD ST., LONDON, E.C.2.

CLARENCE CHAMBERS, 39, CORPORATION STREET, BIRMINGHAM.
13, RUMFORD STREET, LIVERPOOL.

PIG IRON

All grades FOUNDRY, HEMATITE, BASIC, SPECIALS, &c.

NON-FERROUS METALS

COPPER, TIN, LEAD, SPELTER, ANTIMONY, CHROME ORE.

WILLIAM JACKS & COMPANY
LIMITED
CENTRAL CHAMBERS, 93, HOPE ST., GLASGOW, C.2
ZETLAND ROAD, MIDDLESBROUGH.

Notice

Small Advertisements in this section of the Journal are accepted at the prepaid rate of 2d. per word in ordinary type and 3d. per word in capitals.§

Minimum charge for one insertion 4/-

(A remittance should accompany instructions.)

SITUATIONS VACANT AND WANTED

ASSISTANT Foundry Manager seeks advancement (age 30). Non-ferrous, aluminium, high lead bronzes, copper lead lining. Mechanical plant. Competent organiser. —Box 668, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

FIRST-CLASS Foundry Manager, age 38, desires change where experience of full control of all departments D.O., patternshop, ferrous and non-ferrous foundries and sales, can be used for national effort. Marine engine and turbine castings up to 40 tons; machine tool and general engineering castings to close specifications, high-duty, grey-iron and manganese bronze included. Full particulars on request.—Box 682, FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

FOUNDRY MANAGER wanted for Jobbing Foundry in Manchester area.—Apply, stating age, experience and salary required, to Box 670, FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

FOUNDRY and Pattern Foreman, iron and brass; twenty hands; repetition small castings and few specials up to 10 cwts. King's Lynn district. Full particulars training, experience, salary required, when free. Please apply through the King's Lynn Employment Exchange.

LARGE Engineering Works in the North of England requires a metallurgist or chemist having engineering works experience, preferably with specialised knowledge of heat-treatment and metallography of high-speed steel or of physical chemistry of gases. No routine work. Graduates between 25 and 35 years of age should apply in writing, giving full details of experience, to Box 678, FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

METALLURGICAL CHEMIST wanted for Jobbing Foundry in Manchester area.—Apply, stating age, experience and salary required, to Box 672, FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

WANTED.—A man with good knowledge of chemistry and metallurgy, to take charge of an electric steel-melting plant in the North Riding of Yorkshire.—Apply in writing, Box 662, FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

WANTED, for South Manchester district, Woman Analytical Assistant to Engineering Works Laboratory. Should have 2 to 3 years' experience of routine analysis of carbon steels.—Apply by letter, stating age, experience and wage required, to Box 674, FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

AGENCY

WELL-ESTABLISHED firm in Midlands, with close connection with all leading engineering, industrial and aeronautical foundries, requires additional representation for foundry plant or supplies. Excellent references can be given. Energetic and technical service assured by practical and experienced staff.—Box 660, Offices of THE FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

MACHINERY

WANTED.—Rotary Table Sand Blast Plant, table 7 to 8 ft. diameter. Must be in good condition.—Box 676, FOUNDRY TRADE JOURNAL, 3, Amersham Road, High Wycombe.

MACHINERY—*Continued*

WANTED.—Tensile and Elongation Testing Machine, suitable for work up to 20 tons per sq. in.—Please give full particulars of age, price, etc., to E. HIND (SOUTH BANK), LTD., South Bank.

PNEUMATIC MOULDING MACHINES

Macdonald Jolter, table 72 in. by 54 in.

Tabor ditto, table 27 in. by 20 in.

Tabor 21 in. by 16 in. squeeze.

Zimmerman Type R.P.W. 2 Jolt Squeeze turnover, table 36 in. by 20 in.

Mumford Type (Jackman) Swing Headpress, 13 in. by 15 in. and 14 in. by 16 in.

Mumford Pneumatic Core Jolters having 15-in. by 20-in. and 12-in. by 12-in. tables.

Britannia No. 1 "Coventry" Pneumatic Turnover Jarr Ram, table 30 in. by 28 in.

50 Air Compressors; 500 Electric Motors, Dynamos, etc.

S. C. BILSBY, A.M.I.C.E., A.M.I.E.E.
CROSSWELLS ROAD, LANGLEY,
Nr. Birmingham.
'Phone: Broadwell 1359.

NEW Dwarf Cupola, to melt 10 to 15 cwts. per hour; New Worm-geared Ladles, 4-tons, 2-tons, 30-cwts., 20-cwts., 15-cwts. and 10-cwts. capacity; also Osborn Cupola Spark Arresters.—T. DAVIES & SON, West Gorton, Manchester, 12.

FOR SALE.—3 Turnover Moulding Machines, by Darling & Sellars. One 3 ft. by 19 in. table; two 2 ft. 6 in. by 19 in. tables.—Apply, BELLOW MACHINE CO., LTD., Grafton Street, Leeds, 7.

THOS. W. WARD, LTD.

CENTRIFUGAL PUMPS.

18 in. suction, 16 in. delivery, 5,000 galls. per hr., 20 ft. head. By Beardmore.

16 in. suction and delivery, 4,000 galls. per hr., motor drive.

14 in. suction and delivery, steam drive. Worthington Sisson.

8 in. suction, 6 in. delivery, 1,500 galls. per hr., motor drive. By Submersible and J.L. Motors.

6 in. suction and delivery, belt drive. By Beardmore.

5 in. suction and delivery, motor drive. By Drysdale.

4 in. suction and delivery, belt drive. By Pulsometer.

UNUSED 5 IN., 2 STAGE MEDIVANE MOTOR DRIVEN CENT. PUMP, 50 h.p. motor, 400 volts, 3 phase, 50 cycles. Ellison starter.

Write for "Albion" Catalogue.

ALBION WORKS, SHEFFIELD
'Grams: "Forward." 'Phone: 26311 (15 lines).

TWO adaptable SQUEEZE MOULDING MACHINES, to suit moulding boxes up to 18 in. by 16 in.

One Adaptable PORTABLE RIDDLE, fitted with 400 volt, 50 cycle, 3 phase A.C. Motor, ¼ h.p.

One GAS-HEATED CRUCIBLE FURNACE, 100 lb. capacity, complete with fan, motor and switchgear. Keith Blackman Fan, 100 cub. ft. per minute at 20 in., 3 in. outlet, 400 volt, 50 cycle, 3 phase Motor, 2 h.p.

One Type E/100 ELECTRICAL INDICATOR, ranged 0/800 deg. Centigrade, instrument No. E./2878, fitted with one type E/255 Thermo Couple, ranged 2 ft., with 4 yards of type G/188 cable, made by Negretti & Zambra.

Four pairs CAST-ALUMINIUM BOXES, 16 by 12.

Four pairs CAST-ALUMINIUM BOXES, 18 by 16.

Five pairs CAST-ALUMINIUM BOXES, 17 by 15.

VERY LITTLE USED, AND IN PERFECT CONDITION.

MORLAND & IMPEY, LTD.,
NORTHFIELD, BIRMINGHAM, 31.
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